NOVEMBER, 1921 THIRTY CENTS

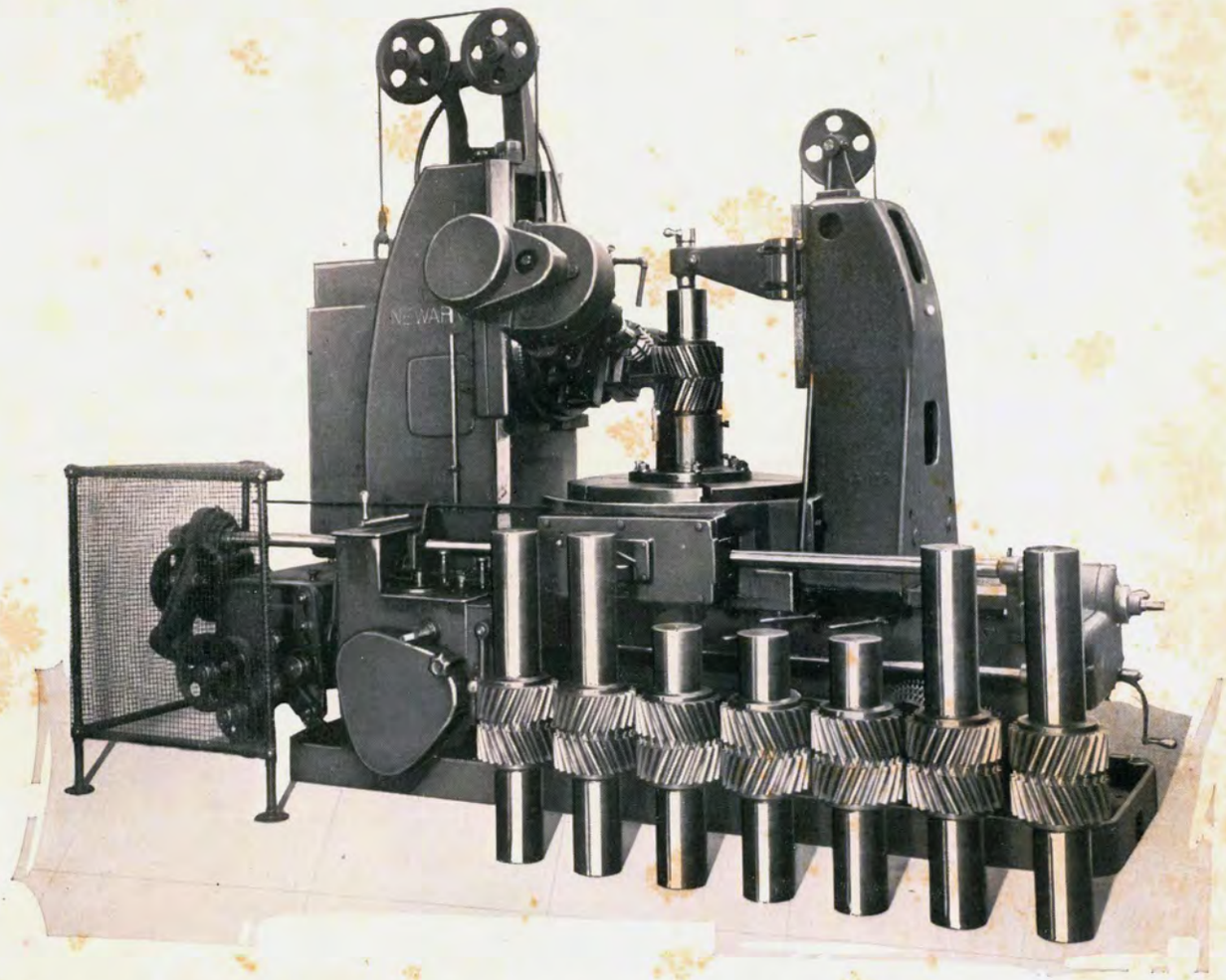
The SIBLEY JOURNAL of Engineering

PUBLISHED BY THE STUDENTS OF SIBLEY COLLEGE
CORNELL UNIVERSITY, ITHACA, N.Y.

I am the Red Cross of Peace —
I heal the wounds of war —
I am a refuge from fire, flood and pestilence —
The love of little children is mine —
I am the Red Cross of Peace —
American Red Cross
"In the service of those who suffer"

VOL. XXXV No. 11

NEWARK GEAR—



NEWARK GEAR HOBBING MACHINE= Cutting rolling Mill Pinions. The growing demand for herringbone and single helical gears, requires that they should be cut on the proper machine.

The name NEWARK on a Hobbing Machine, means that the machine represents the highest development of this class of production tool. The pioneer hobbing machine in this country, is still the acknowledged leader.

The NEWARK machine embodies differential gearing; this mechanism permitting helical leads to be accurately obtained, without the usual complex mathematics required on other hobbing machines.

Our machines are the result of many years of experience. Wirte for descriptive circular, explaining the mechanism.

Newark Gear Cutting Machine Co.

NEWARK HENRY E. EBERHARDT, President N. J., U. S. A.

How Much Lubrication Does Your Dollar Buy?

Reg. U. S. Pat. Off.

A MARK
Known and Respected
around the world
Since 1868
for
fair dealing
a quality product
and an
unexcelled service

HOW much of the cup grease that your dollar buys is used in doing useful work, and how much is lost by leaking out and spattering about? How much of it is lost through spoilage? How much is burned up by excessive friction? Or do your bearings burn out through poor lubrication and you get no value out of the grease at all - but actually lose money on it.

ALBANY GREASE

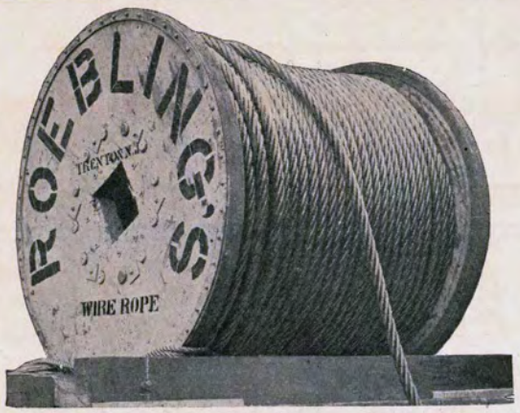
gives you a 100 cents value for every dollar you spend on lubrication. It feeds only enough to overcome friction and does not drip or waste away. It protects the bearing and contains no injurious ingredients. It conserves power and is useful to the last drop.

Your dealer stocks it because he knows it's good. Send for a sample large enough to make a real test.

Write for Bulletin J-1.

ADAM COOK'S SONS
708-710 Washington St.,
NEW YORK, N. Y.

Albany Grease



ROEBLING

WIRE ROPE

Successfully used since 1840

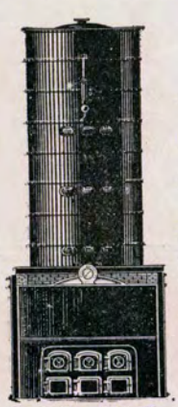
John A. Roebling's Sons Company

Trenton, New Jersey

MANUFACTURERS OF WIRE ROPE AND WIRE

ADVERTISERS

	PAGE
Adam Cook's Sons	3
American Steam Gauge & Valve Mfg. Co.	8
Auburn Ball Bearing Co.	16
Cornell Co-Op	14
Damascus Bronze	14
Direct Separator Co.	10
Higgins & Co., Chas. M.	16
Kennedy Valve Co.	16
Keystone Lubricating Co.	5
Koehring Machine Co.	13
Lefax	8
Lidgerwood Mfg. Co.	12
Lunkenheimer Co., The	19
McIntosh & Seymour Corp.	10
Mississippi Wire Glass Co.	11
Morse Chain Co.	6
Newark Gear Cutting Machine Co.	2
Niles Bement Pond Co.	8
Otis Elevator Co.	15
Robinson & Co., Dwight P.	16
Roebling's Sons Co., J. A.	4
Samson Cordage	16
Sibley College	18
Spray Engineering Co.	12
Starrett Co., L. S.	11
Tuberculusis Association	9
U. S. Ball Bearing Co.	17
Western Electric Co.	7
Westinghouse Elec. & Mfg. Co.	Back Cover
Wickes Boiler Co.	4



Steel Cased Setting Increases Efficiency

REDUCE BOILER ROOM COSTS

Use the Coupon

THE WICKES BOILER CO. Saginaw, Michigan

Gentlemen: Without obligation on my part, I would like to read your educational technical bulletins as checked:

Bulletin 2. Aids in the Selection of a Steam Boiler with a Peep at the Wickes Vertical Water Tube Boiler.

Bulletin 3. Reducing Costs in the Boiler Room.

Bulletin 4. The Magnitude and Prevention of Air Infiltration Losses.

Bulletin 5. Saving Coal in Steam Power Plants.

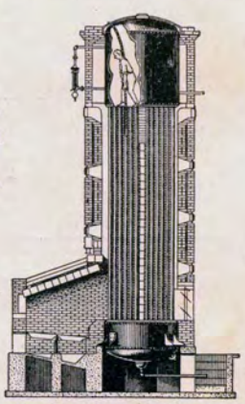
Bulletin 6. The Utilization of waste Heat for Steam Generation.

Name .....

Business Address .....

Home Address .....

Date .....



Man Stands Erect Cleaning

THE DOMINANT CONSERVATION FACTOR

KEYSTONE Lubricants Conserve Power

Which?

Once every seven weeks or twice every day

Because of the high cost of labor, of every grade, the time and labor-saving features of Keystone Grease alone should be sufficient reason for its adoption.

One user writes that he fills his grease cup but *once in seven weeks instead of twice every day*—and is receiving a vastly more efficient lubricating service since adopting the Keystone Venango Gravity Grease System and

KEYSTONE GREASE

THE MASTER LUBRICANT

"Makes the Most Efficient Mechanical Unit MORE Efficient"

Industrial America Moves on Keystone Grease

Keystone Grease is the result of scientific investigation covering the experience of a life time in the developement of every phase of lubrication.

Where Keystone Grease is used, not only are oiling costs cut to the core, but infinitely better lubrication is secured, more power released for increased production, hot boxes and scored bearings disappear for all time, costly repairs and expensive shutdowns necessitated by improper lubrication are entirely eliminated.

Learn more about the world-wide lubrication service Keystone Grease has built on a purely efficiency basis. Why not arrange for a trial installation of the Keystone Venango Gravity Grease System at our expense?

KEYSTONE TRADE MARK Reg. U.S. Pat. Off. GREASE

The Master Lubricant

THE KEYSTONE LUBRICATING COMPANY

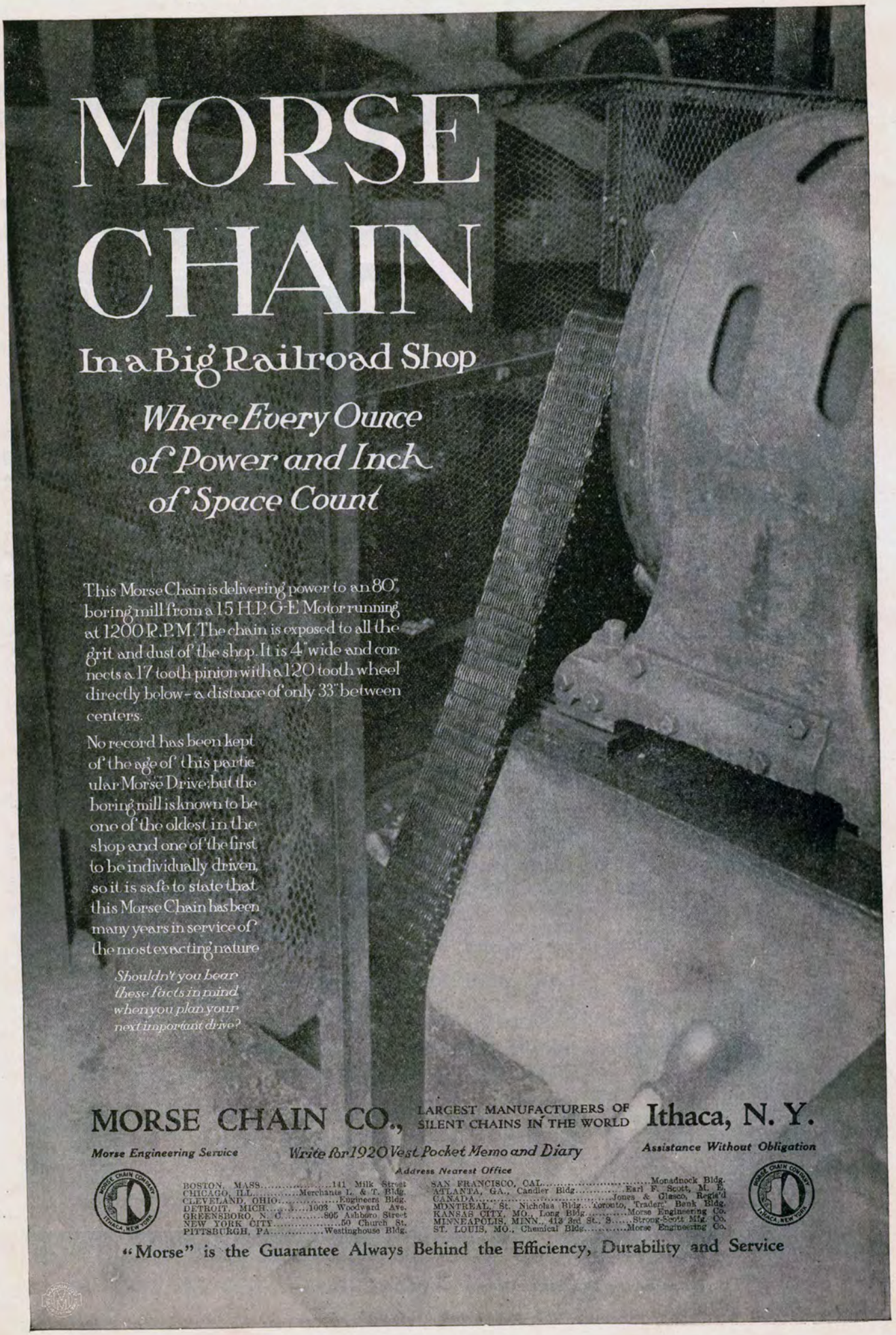
New York
Boston
Pittsburgh
Chicago
Detroit

Executive Office and Works:
Philadelphia, Pa.
Established 1884

St. Louis
Denver
San Francisco
Minneapolis
Houston

Agencies in Principal Countries Throughout the World

UNIVERSALLY KNOWN UNIVERSALLY USED



MORSE CHAIN

In a Big Railroad Shop

Where Every Ounce of Power and Inch of Space Count

This Morse Chain is delivering power to an 80" boring mill from a 15 H.P. G-E Motor running at 1200 R.P.M. The chain is exposed to all the grit and dust of the shop. It is 4" wide and connects a 17 tooth pinion with a 120 tooth wheel directly below - a distance of only 33" between centers.

No record has been kept of the age of this particular Morse Drive; but the boring mill is known to be one of the oldest in the shop and one of the first to be individually driven, so it is safe to state that this Morse Chain has been many years in service of the most exacting nature

Shouldn't you bear these facts in mind when you plan your next important drive?

MORSE CHAIN CO., LARGEST MANUFACTURERS OF SILENT CHAINS IN THE WORLD **Ithaca, N. Y.**

Morse Engineering Service *Write for 1920 Vest Pocket Memo and Diary* *Assistance Without Obligation*

Address Nearest Office

BOSTON, MASS.....141 Milk Street
CHICAGO, ILL.....Merchants L. & T. Bldg.
CLEVELAND, OHIO.....Engineers Bldg.
DETROIT, MICH.....1003 Woodward Ave.
GREENSBORO, N. C.....805 Ashboro Street
NEW YORK CITY.....50 Church St.
PITTSBURGH, PA.....Westinghouse Bldg.
SAN FRANCISCO, CAL.....Monadnock Bldg.
ATLANTA, GA., Candler Bldg.....Earl F. Scott, M. E.
CANADA.....Jones & Glasco, Regis'd
MONTREAL, St. Nicholas Bldg...Toronto, 'Traders' Bank Bldg.
KANSAS CITY, MO., Long Bldg.....Morse Engineering Co.
MINNEAPOLIS, MINN., 413 3rd St., S.....Strong-Scott Mfg. Co.
ST. LOUIS, MO., Chemical Bldg.....Morse Engineering Co.

"Morse" is the Guarantee Always Behind the Efficiency, Durability and Service

THE SIBLEY JOURNAL OF ENGINEERING

CORNELL UNIVERSITY — ITHACA, N. Y.

Vol. XXXV — NOVEMBER, 1921 — No. 11

THE SIBLEY JOURNAL OF ENGINEERING

Published by the students of

SIBLEY COLLEGE, CORNELL UNIVERSITY

THE 1921-22 BOARD

George M. Bishop '22 ..... Editor-in-chief
R. A. Esterbrook '23 ..... Business Manager
C. V. Topliffe '23 ..... Managing Editor
H. F. Conrad '23 ..... Assistant Editor
H. H. Duryea '24 ..... Assistant Editor
F. A. Hoffman '24 ..... Circulation Manager
C. T. Morrow '23 ..... Advertising Manager
Joseph Lendway '23 ..... Sales Manager

ASSOCIATE EDITORS

Dean Dexter S. Kimball, A.B. M.E.
Professor William N. Barnard '97, M. E.
Professor Albert E. Wells
Asst. Prof. J. G. Pertsch '09 M.E.
Asst. Prof. M. A. Lee '09 M.E., '13 M.M.E.

Published by

THE SIBLEY JOURNAL OF ENGINEERING, INC.

ITHACA, N. Y.

Founded 1885 — Incorporated 1916

George M. Bishop '22, President
Asst. Prof. J. G. Pertsch, Jr., '09, Vice-President
R. A. Esterbrook '23, Treasurer
C. V. Topliffe '23, Secretary

THE PUBLISHERS' ANNOUNCEMENT

SUBSCRIPTION PRICES:

United States, Mexico and Canada, $3.00 a year
Foreign, $3.25 a year, payable in advance

Remit by postoffice or express money orders, bank checks made payable to THE SIBLEY JOURNAL OF ENGINEERING, INC. Should a subscriber desire to discontinue his subscription, notice to that effect should be sent in before its expiration. Otherwise it is assumed that a continuance of the subscription is desired.

We are glad to extend the privilege to our cntemporaries of republishing extracts from THE JOURNAL provided that we are notified of such intention and that proper credit be given.

An index will be published as a part of January number of each year.

ADVERTISING

The rates for advertising will be quoted on application. Copy should be in the hands of the publishers by the 5th of the month preceding publication.

THE SIBLEY JOURNAL OF ENGINEERING, INC.
Ithaca, N. Y.

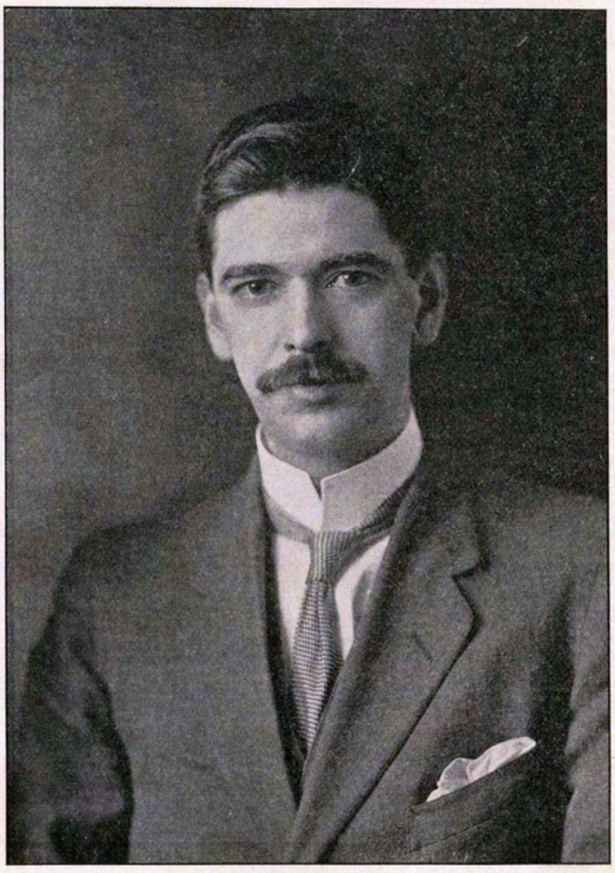
Important Announcements

Due to the fact that Prof. G. B. Upton is in California, we are again forced to omit his article on Automobile Construction. We greatly regret that we have to do this, but it is impossible to get in communication with him, as his address is at present unknown. However, we hope that the next of his series will arrive in time for the December issue.

Some of our undergraduate readers may have noticed the brown boxes marked "Sibley Journal of Engineering," which have been put up in various places about the Engineering College buildings. It has been said in the past that the undergraduate engineers do not give the Journal a very cordial response because the articles in it are "above their heads." In order to correct this difficulty as much as possible, we have had the boxes made and placed at points where they are easily accessible to the student body. Any suggestions which a person may have, any little ideas about how conditions may be improved either with regard to the Journal itself, or with regard to the Engineering College as a whole, any brilliant thoughts which come to a student in the laboratory, will reach the Journal Board if they are dropped in the slots in the tops of these boxes. We hope the students will take full advantage of this opportunity.

CONTENTS FOR NOVEMBER 1921

Announcements 141
Obituary—Prof. A. Gray.... 143
The Problem of Fuel for Aviation Engines, by Prof. Kutzbach, of Dresden..... 146
1,500,000 Volts..... 151
Get-Rich-Quick Schemes, by James F. Meister, M.E.'05. 152
University Notes 153
Personals 155
Engineering Abstracts 156



Professor Alexander Gray, B.S., M.S.

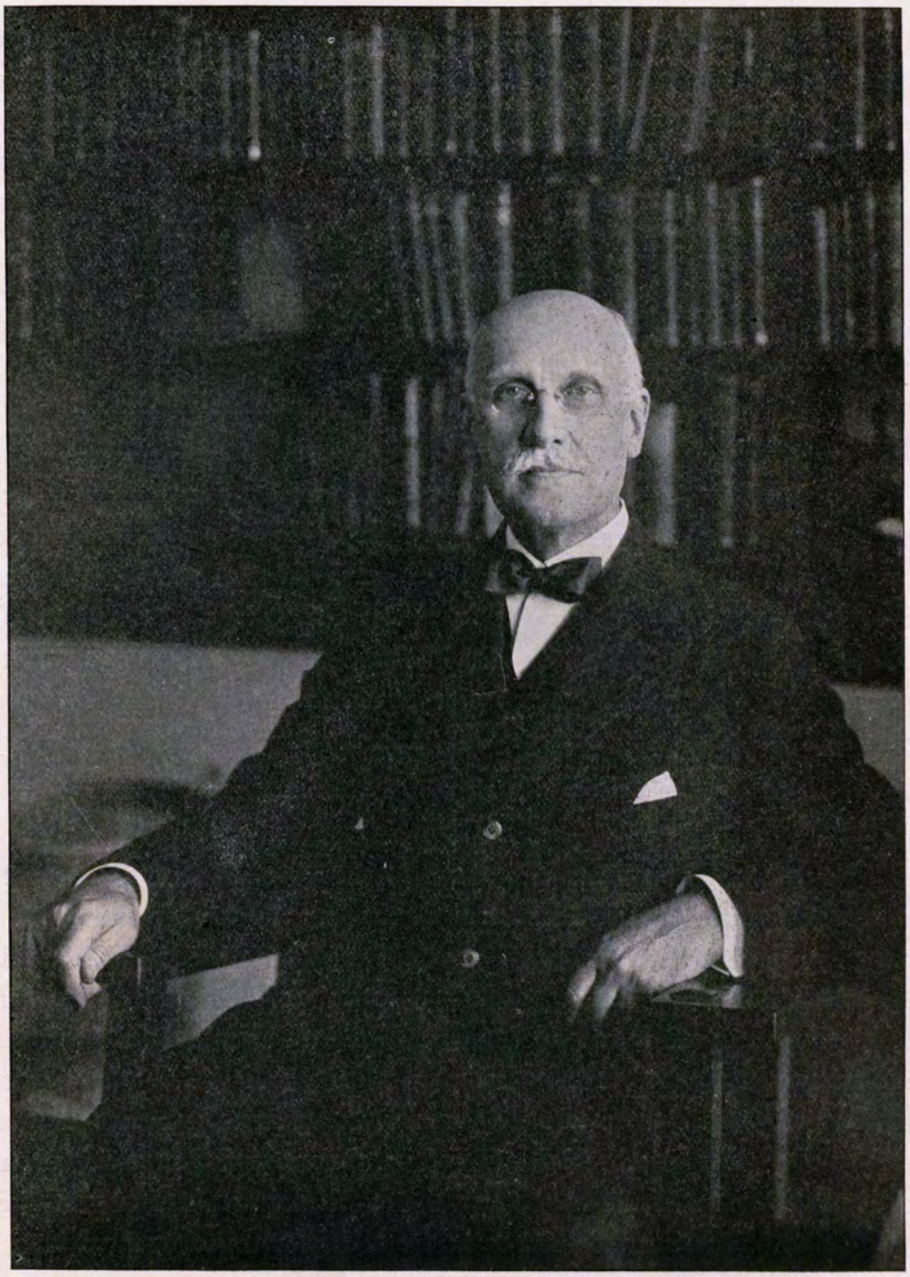
ALEXANDER GRAY, Director of the School of Electrical Engineering at Cornell University, and well known as a writer and authority on electrical machinery, died in Ithaca on October 13, 1921, after a lingering illness.

Professor Gray was born in Edinburgh, Scotland on March 9, 1882. While serving his apprenticeship he attended evening classes at Heriot-Watt College and graduated from Edinburgh University in civil and mechanical engineering in 1903. Awarded a Whitworth Scholarship, he then spent two years at McGill University, Montreal, in the study of electrical engineering. After graduating from McGill University, Professor Gray joined the engineering staff of the Bullock Electric Company, of Cincinnati, and two years later transferred to the staff of the Allis-Chalmers Company at Milwaukee. During his five years of service with these companies he gained a wide experience in the design, construction and operation of all types of electrical machinery.

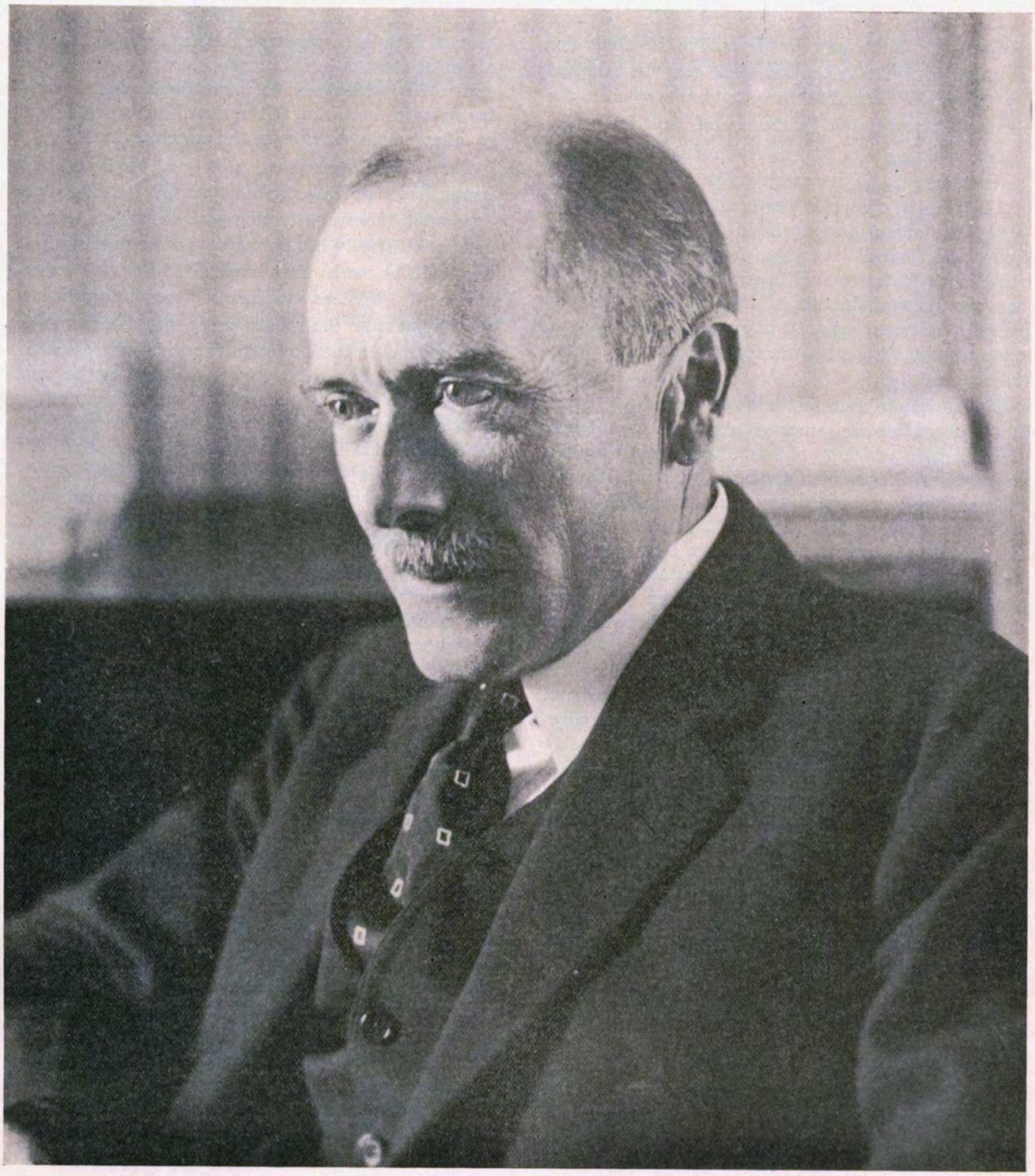
In 1910 Professor Gray accepted an appointment as assistant professor of electrical engineering at McGill University, and in 1915 he was chosen to fill the position of head of the electrical engineering department in Sibley College, Cornell University. Upon reorganization of the college of engineering at Cornell last year, Professor Gray was made Director of the School of Electrical Engineering. A man of fine personality, a charming companion and an exceptionally strong teacher, from the very beginning of his professorship he made a warm place for himself with both students and faculty.

Professor Gray was granted a considerable number of patents for electrical apparatus. He also contributed largely to the literature pertaining to electrical machinery, and his two books on "Electrical Machine Design" and "Principles and Practice of Electrical Engineering" are favorably known to the profession. In 1918 he was the recipient of the Howard N. Potts Medal of the Franklin Institute for his paper on "Modern Dynamo Electric Machinery". Professor Gray was also a member of numerous educational and honorary societies; he took an especially active interest in the work of the American Institute of Electrical Engineers, and served on a number of its technical committees.

In his death, the profession of electrical engineering loses a brilliant engineer and a great writer, and the teaching profession a teacher of rare ability. His place at Cornell will be difficult to fill.



RETIRING ACTING PRESIDENT ALBERT WILLIAM SMITH



PRESIDENT LIVINGSTON FARRAND

THE PROBLEM OF FUEL FOR AVIATION ENGINES

Lecture given by Professor Kutzbach, of Dresden, Scientific Collaborator of the Adlershof Aeronautical Laboratory.

The speaker began by mentioning the physical properties which may be demanded of fuels for aviation use and the means that may be adopted by the engine manufacturers to properly meet the demands necessitated by the use of such fuel.

In the choice of a fuel the following factors must be considered: (1) its composition; (2) the quality available; (3) the price per heat unit; and (4) the possibility of keeping stocks in aerial ports both at home and abroad. It is also important to know if the change from one fuel to another will necessitate any serious modification of the engine. With the present universal scarcity of gasoline, the day will certainly come when heavier fuel will have to be considered.

The storing of fuel in the airplane and supplying it to the engine are other points to be considered. Gaseous fuel, which would have to be taken aboard in large gas bags or in air-tight cylinders, cannot be considered as the primary fuel on account of the space occupied by and the weight of such containers. At best it might be carried in liquid form in heat-proof containers. Solid fuels which might be pulverized or are in the form of powder (explosive material) cannot be considered, although liquefiable or soluble fuels such as naphthaline or paraffin might be used. Liquid fuels of high calorific value per unit of weight are best adapted to the purpose. Such fuels are the saturated and unsaturated hydrocarbons which not only have a high calorific value per unit weight but which may be easily supplied the engine in a very fluid state. Considering the fact that airplane engines must be capable of operating near the ground in the intense heat of summer and also at high altitudes in the severe cold of winter, the question of fuel supply is not of the simplest because many fuels lose their fluidity at extremely low temperatures. Special measures must therefore be taken so that at least the portion immediately required for the engine may be kept in a very fluid state either by heating with hot water, hot oil or electrical energy.

One of the most important points to be taken into consideration is that of ensuring the safety of fuel from ignition in case of leaks in or injury to the tanks and connecting pipes such as may occur in forced landings. This brings out a property demanded of the fuel by the manufacturers of airplane engines, namely the possibility of quickly and easily supplying to the engine a good combustable mixture without the necessity for preparing such a mixture at a temperature or pressure other than that of the free air at the altitude at which the engine is operating. An ideal fuel would be of such a nature that it does not evaporate instantaneously in free air or at least does not form a mixture that ignites easily, but which can be mixed and gasified satisfactorily in the carbureter and will form a sufficiently inflammable mixture in the engine cylinder.

These conditions have not yet been fulfilled. Apart from insuring the safety of all the fuel pipes by double tubes and double jackets, they might be met satisfactorily in two ways. In the first of these use could be made of an explosive fuel that evaporates easily, such as gasoline or benzol, supplied in such a manner that there is no possibility of delivering fuel to the engine in excess of its instant requirements. For this purpose the fuel in the tank would have to be condensed to such an extent or kept at such a low temperature that it resembles an ointment in fluidity and will not flow out of a leaky tank or it might be absorbed by some special substance to prevent its escape. In the second way, fuels could be used that do not readily gasify, i. e., fuels with high boiling points and flash points. The carburetor would be so designed or the intake air and fuel would be brought to such a condition in the manifold or in the cylinder that mixing and ignition would be satisfactory. The important question of the utilization of fuels of lower inflammability and consequently of higher boiling point and lower cost would thus depend on the engine.

The preparation of the fuel mixture in the carburetor was then discussed. The carburetor functions primarily as an ejector pump as shown in Fig. 1. The following equation (1) expresses its metering relations

$$\frac{W_a}{W_f} = \frac{A_a}{A_f}\sqrt{\frac{D_a}{D_f}\,\frac{P_a}{P_f}}$$

W_f and W_a signify the weight of the fuel and of the air respectively and should preferably be used as a clearly defined ratio, usually in airplane engines one giving a slight excess of air or of fuel; A_f and A_a the cross sectional areas of flow; D_f and D_a the densities of fuel and air at the mixing point; and P_f and P_a the pressure drops at the nozzles in millimeters of water. The air velocities are only indirectly stated in this equation in the value D_a which falls very slowly with increasing values of r.p.m.

In changing from one fuel to another, the fuel nozzle A_f must be so altered that the new fuel requirement W_f of air shall be proportional to the square root of the density D_f. The ratio of the two areas would therefore be given by equation (2)

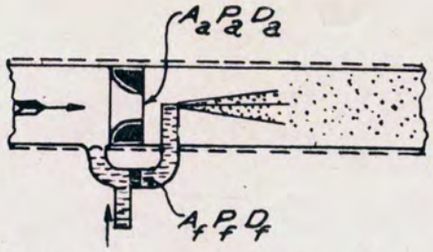


Fig 1. DIAGRAM OF CARBURETOR

$$\frac{A_f''}{A_f'} = \frac{W_f''}{W_f'} \sqrt{\frac{D_f'}{D_f''}}$$

when W_f' or W_f'' represents the weight of completely burnt fuel in chemically combining proportions with the unit weight of air.

We further see by equation (1) that the mixture ratio changes with change in altitude of flight as D_a diminishes as the altitude increases, while D_f remains unchanged in the case of liquid fuel. $\frac{W_a}{W_f}$ would therefore decrease as $\sqrt{D_a}$ with increased altitudes, and the engine would therefore consume more and more fuel unless preventive measures were taken. The influence of temperature is likewise expressed in D_a so that the mixture would be richer in warm weather; that is, with reduced air density.

It is especially important that any possibility of separation of the fuel and air, either in the manifold or cylinder, should be prevented. There are two fundamental ways of doing this:

1. By the finest possible atomization, whatever the load and engine speed may be. This has been proved by experience to be accomplished by high air velocities and low fuel viscosities.* Atomization with slow engine speed may often be found difficult.

2. By evaporization of the whole or main part of the fuel, so that there is no longer any possibility of its separation from the air.

There is no object to be gained, however, by the vaporization of the fuel before the fuel nozzle except in the case of liquids having a very low boiling point, such as liquefied illuminatiig gas, methane, etc. The boiling point of the ordinary engine fuels is too high at atmospheric pressure. At atmospheric pressure the boiling point is far higher than atmospheric air temperatures. When light gasoline is used, provision must be made for adequate cooling at high altitudes, as it would otherwise attain boiling point on account of the low air pressure, thus deranging the formation of the mixture and causing the engine to stop working.**

For liquid fuel the vaporization therefore best takes place after leaving the fuel nozzle when it is surrounded by the air for combustion which must also supply the heat for evaporation.* As about 12½ m.^{3} (441 cu. ft.) of air combine with 1 kg. (2.2 lbs.) of gasoline or petroleum, the volume of the gasoline vapor is only about 1/50, and that of petroleum only 1/200 that of the air, so the partial pressure of the fuel vapor is therefore only 1/200 of the atmospheric pressure; and the process of evaporation takes place more easily than without such low partial pressures of fuel vapor.

The quantity of liquid fuel passed through the nozzle therefore evaporates extremely rapidly in the air in consequence of its low partial pressure,—the boiling point being considerably lower than with atmospheric pressure—and continues until the saturation point of the air is reached. The air is more or less saturated after the evaporation of the fuel, depending on the boiling points of the fuel, its vapor volume and the temperature of the air. The curves in Fig. 2 show that with hexane air is saturated at —18° when there is the quantity of hexane (the principal component of gasoline**) necessary for good combustion, so that when the air is cooled about 30°C by evaporation, air of about +15°C suffices to bring about complete vaporization.*** The intake air at +15°C is at first entirely free from fuel; it then evaporates rapidly, cooling and increasing the fuel content of the air at the same time. At —15°C its percentage of saturation amounts to 85 per cent when the entire fuel needed for combustion has evaporated.

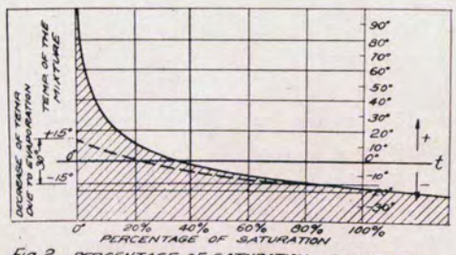


Fig. 2. PERCENTAGE OF SATURATION OF A HEXANE AIR MIXTURE AT SEVERAL TEMPERATURES

Similar values are given in Table I for hexane, benzol, ethyalcohol, decane (a component part of petroleum) and naphthaline, the approximate boiling points at atmospheric pressures are also given.

TABLE I.

Fuel	Boiling Point	Saturation temperature of the fuel mixture	Drop in temperature due to evaporation	Temperature of the air for complete evaporization higher than
Hexane	70°C	—18°C	30°C	15°C
Benzol	80°	— 5°	30°	30°
Ethyl Alcohol	78°	+22°	110°	135°
Decane	160°	+42°	35°	80°
Naphthaline	220°	+92°	40°	135°

*See Note I.
**See Note II.

*See Note III.
**See Note V.
***See Note IV.

In the case of alcohol, the cooling of the air is remarkably great, chiefly because of the small amount of air in the combustion mixture, and the high latent heat of vaporization which must be supplied by that small quantity of air. Only fuel mixtures with a temperature sufficiently higher than the saturation temperature can be entirely vaporized in the short time available and thus be insured against any separation of fuel and air. Below the saturation temperature, part of the fuel is always in the form of fog or small droplets, and the larger the drops the greater is the possibility of the separation of the fuel.

If, however, all the walls of the pipes and of the combustion chamber be maintained at temperatures above that of saturation by the aid of the natural heat of the machine, of the heat of cooling water or of the exhaust, the risk of the separation of the mixture is sensibly diminished.*

There are two methods of using fuel with high boiling points, either or both of which may be applied separately or simultaneously: first, by atomizing the liquid as finely as possible at all loads; and second, by increasing the temperature of the fuel mixture and walls above the saturation temperature of the fuel-air mixture.

This increase in the temperature of the mixture and walls is difficult when starting the engine cold as it requires time to obtain heat from some source and transfer it to the mixture. The most convenient method is to start with fuel of a low boiling point and run until the desired temperatures are attained. There is one great disadvantage to be considered in the increase in temperature of the mixture, namely, the great difference in the heat supplied by the engine at different loads. In the case of the airplane engine, which is almost always fully loaded, this disadvantage is fortunately of no great importance.**

The first consequence of the increased temperature of the mixture and walls is a reduction in volumetric efficiency, E_v and likewise of the mean effective pressure of the engine, due to the decreased density of the air. The following equation gives the mean pressure:

$$P_m = \frac{427 \cdot E_t}{10000} \cdot H \cdot E_v \text{ ***} \quad \ldots\ldots (3)$$

in which E_t indicates the thermal efficiency, and H the heating value of a unit volume of the mixture. If the air be adequatetly heated so that the mixture enters the cylinder at its saturation temperature, an alcohol mixture would have to be 27° warmer than one of gasoline since the saturation temperature of the former is +22°C while that of the latter is —5°C. This increase in mixture temperature would result in a 10 per cent loss of air weight at full throttle. A naphthaline-air mixture at 92° would give a greater loss. In both cases there is a loss of intake oxygen, of E_v and consequently of power. The higher the saturation temperature of the mixture as for gas-oil and heavy tar oils, the higher the point to which the preliminary heating must be carried.

It would obviously be a good plan to transfer the process of mixing to the combustion chamber itself, in order to heat the walls of the combustion chamber and also the fresh air supply in the shortest possible time. This would, however, necessitate the rejection of the simple yet marvelously effective air ejector as an atomizing and mixing device, and its replacement by a compressed air atomizer or even by the simple spraying of the required amount of fuel by means of a special pump. The less effective the atomization, the longer will be the time required for vaporization, and as vaporization must be finished before ignition begins, the unfavorable atomization must be compensated for by greatly increasing the temperature of the air.

This is particularly evident in the case of engines ignited by incandescence, the air into which the fuel is injected being heated to an unusually high temperature through the redhot, or at least extremely hot, uncooled walls. It is certainly possible to utilize all kinds of fuel with a high boiling point in these engines, but there is a great disadvantage in the unfavorable cylinder efficiency and in the afterburning of the fuel, which is too slowly vaporized and poorly mixed. For these reasons, the solution offered cannot be considered satisfactory.

The lecturer went on to say that he had personally tested the possibility of utilizing fuel with a high boiling-point by means of injection into the combustion chamber with compressed air atomizers, and that such injection could be made at any moment desired. The results showed the operation of the engine to be least reliable when injection was completed just before the ignition, although the air in the engine was then at the highest temperature. The operation was satisfactory only when injection took place while air was being taken in, in which case the prolonged period of carburetion and the stronger air currents certainly caused favorable effects. (In the case of two-stroke engines, injection can take place only during the process of scavenging or compression.) The compressed air can be used for atomization or the air can be supplied at a higher velocity, by Bellem and Breger as' process,* by using a very much reduced pressure in the combustion chamber during a portion of the intake stroke. By these methods there are still various possibilities of rendering fuels with a high boiling point utilizable without the great disadvantage of a marked rise in temperature outside the combustion chamber itself.

The increase in the temperature of the mixture during the intake stroke entails another disad-

*See Note VIII.
**See Note IX.
***See Note X.

vantage besides the reduction of volumetric efficiency, namely, that of very considerably increasing the average temperature during the whole cycle, particularly the temperature during compression. This is a very great disadvantage as it increases the risk of premature ignition in the mixture.

With regard to premature ignition itself, too little is known about it at present to enable us to give a clear and unbiased judgment as to its cause. The results that have been obtained present many facts tending to general enlightenment, and the engine itself shows most readily how it is affected by fuels and temperature.

The influence of the initial temperature of the mixture on the maximum temperatures at the conclusion of compression is shown in Fig. 3. If the compression ratio is 1 : 5, the compression temperature amounts to about 300°C, 500°C or even 700°C with initial temperatures of 0°C, 100°C, or 200°C. Supposing the limit of admissible compression temperatures to be about 400°C, the compression ratio must be reduced in proportion to the increase in the initial temperature. Experience has shown, however, that totally different degrees of compression are necessary in one and the same engine for different fuel mixtures; that the shape of the combustion chamber, the temperatures of the badly cooled parts, such as the piston, the exhaust valves and the spark plug, and the freedom of the top of the piston from carbon deposit have marked effects. In conclusion, we may say that the risk of premature ignition decreases as the weight of charge is reduced, although the compression ratio which determines the temperature at ignition and the composition of the mixture are not thereby altered.

Tests so planned that liquid fuel was brought into contact with air in an electric furnace* in which the temperature could easily be regulated were carried out at the Augsburg Nuremburg Machine Fabrik by Dr. Holm at request of the lecturer. In Fig. 3 the spontaneous ignition temperatures found by means of this somewhat crude method are given. They enable us to draw comparisons and form conclusions with regard to the action of the fuels in engines. They confirm experience which shows that engines with benzol and alcohol are generally far less inclined to premature ignition than with gasoline.

They show also that petroleum and gas-oil, for which the temperature must be raised when they are utilized in the carburetor, possess particularly low spontaneous combustion temperatures, so that there are two reasons for using a low compression ratio with these fuels.

As the thermal efficiency decreases with reduction of the compression ratio, petroleum and gas-oil appear to be most unsuitable for use with a carburetor, and tar oil very well suited. Another difficulty arises through the fact that not only the principal fuel, but also the lubricating oil used may turn the scale in causing spontaneous ignition. Hopkinson* made a remarkable test with an engine using ordinary gas, in which he tried to bring about premature ignition with the air of a red-hot plug, the temperature of which he measured with thermo-elements. It was not until the temperature of the plug was 600° to 700° that premature ignition took place. If a drop of lubricating oil fell on the plug or on the exhaust valve, a temperature of 400° sufficed for spontaneous ignition. The difficult question as to what part is played by lubricating oil in spontaneous ignition, reminding one of spontaneous ignition in air compressors, here plainly crops up again.

An essential provision for the safe operation of engines with prepared fuel mixtures ignited in the engine by means of a special ignition pin is that the compression temperature should remain far lower than that of spontaneous ignition under all conditions. By selecting suitable fuel and suitable lubricating oil, it is certain that several important economical advantages might be attained. The first step necessary would be the systematic investigation of the properties mentioned, namely, the boiling points, saturation and spontaneous ignition temperatures of fuels considered usable, and the effect of these characteristics on the performance of the fuel in the engine.

If, as in the case of gas oil and petroleum, the spontaneous ignition temperature is so low that the engine can probably not be operated economically on account of the low compression ratio, all that remains is to undertake the mixture of the fuel and air immediately before ignition, allowing the mixture to burn like the flame of a gas burner in the air, as was done by Oechelhauser in the case of ordinary gas engines. Diesel applied the process to petroleum and gas-oil. In this way all risk of advanced ignition is avoided, and it becomes possible to increase the degree of compression as desired, and thereby the thermal efficiency. These combustion engines, as the lecturer termed them, in contradiction to ignition engines fired by means of an electric spark,

*See Buchner's Notes on the Benzol question; Fig. 39 in the "Automobile Rundschau" 1913, and Heller's Petroleum Driving Force in Automobiles, Z. d. V. d. Ing. 1919, p. 778.

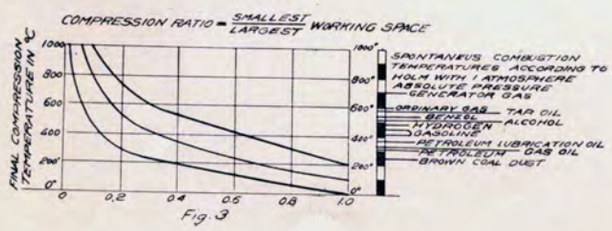


Fig. 3

*See Dr. Holm's article in the "Zeitschrift f. angew. Chemie" ("Journal of Applied Chemistry," 1913, p. 273.)
*See Proceedings of the Institution of Civil Engineers, 1909.

were so designed that the finely atomized incoming fuel meets with fresh air of a temperature far higher than its spontaneous combustion temperature and is, therefore, very rapidly vaporized and burned. The test data given by Holm in Fig. 5 explains the fact that to insure spontaneous ignition of tar oil, the fresh air must be hotter than is needed for gas oil. The combustion engine, however, has the peculiarity that it is impossible for the entire weight of fresh air to be used in the combustion in the short time available. It must, therefore, work with an excess of air, and consequently with lower mean effective pressure. This is occasioned by poor atomization (in engines ignited by incandescence it is usually particularly bad), by the incomplete utilization of the air, and by the increased ratio of piston velocity to ignition velocity.

The lecturer then alluded briefly to the importance of the question of ignition velocity, which plays an important part in the case of high speed engines in particular, and which is as yet insufficiently understood. The well-known researches made at Dresden, by Nagel, Neumann and Nusselt, in burning cold mixtures in a bomb should be extended to as many different fuels as possible. Fig. 6 shows the ignition velocities of various fuel mixtures, set down in terms of the calorific values of the fuel contained in the cubic meter of the mixture, on the basis of Nagel and Neumann's measurements. The values are, like Holm's measurements, most instructive as comparative values. The ignition velocity of the hot mixture in the engine itself is far higher. The so-called limits of ignition of different fuels (according to Eitner) are also given in Fig. 6. They accord fairly well with the ignition limits obtained in the bomb. The calorific values of mixture ratios giving rise to the greatest development of heat in the engine and to the maximum value for the formation of CO_2 are important. This thermal value arises from 700 to 900 gram calories per cubic meter (45 to 59 B. t. u. per cubic inch), according to the heating value and the amount of air required by the fuel; it is a decisive factor in determining the highest possible mean effective pressure (see equation 3) and consequently of the maximum power of an engine with the fuel in question. At the ratio of air to fuel increases, the ignition velocity first increases slowly, then, in the case of some few fuels, as for instance, ordinary gas, it increases rapidly; in other cases, especially with gasoline and benzol, it falls slowly. For the engine, however, the ignition velocity must not be too low, lest after-burning and delaying explosion take place; nor must it be too high, lest the rapid combustion give rise to too violent explosions. With increasing piston velocities, it must, or may be higher. The limits of the ignition velocity utilized in the engine are about 1.5 to 2.5 m/sec. (5 to 8 ft. per sec.) and therefore at these ignition velocities, the thermal value of the mixture would be highest with gasoline, and lowest with hydrogen. This also explains why the highest mean effective pressure ever attained, between 9 and 10 kg/cm², (128 to 142 lbs. per sq. in.) was to be found in the gasoline engine.

This opens up another profitable field of study—that of the ignition velocities of gasoline and all other economically utilizable fuels over a wide range of temperatures from those encountered at the beginning of compression to the temperatures at the end of compression. Nusselt believes the effect of initial temperature is very great.

The lecturer finally considered the question of weight of the aviation engine which must always be more important than the fuel problem.

$$\frac{G}{N} = \left(\frac{P_{max}}{P_m} \cdot \frac{\frac{d}{s}}{V_m}\right) + A \qquad (4)$$

Equation 4 expresses the engine weight per horsepower when the engine is considered as an integration of mechanical energy from several units, and as a transmitter of energy from the several combustion chambers through the piston, connecting rod linkages to the shaft, and thence to the propeller, on which the forces pact at different points. The power N of the engine depends upon (1) the mean value P_m of the forces applied to the pistons and (2) the relative velocity V_m between the moving and stationary parts of the energy conduit. The product $P_m \cdot V_m = N$ remains constant (apart from losses due to friction) in all the cross sections of the energy conduit. The structural material used, and consequently, the weight G is, on the other hand, essentially determined in every section of the energy conduit by (1) the maximum forces P_{max}, (2) the admitted strain s and (3) the specific gravity d of the working material. A is a supplement for the fuel conduits, the valve gear, and other accessories.

The principal determinations for the value G/N are the following: (1) the absolute length (1) of the energy conduit; (2) the permissible value s of the structural material; (3) the permissible maximum values for V_m, and (4) the value $\frac{P_{max}}{P_m}$. The value of $\frac{P_{max}}{P_m}$ for the piston, valve gear and the cylinder is equal to the value of $\frac{P_{max}}{P_m}$ for the entire engine, and in the case of the cylinder and piston, the ratio of the maximum pressure P_{max} to the mean pressure due to inertia of the masses must be taken into account. The following deduction may be drawn from equation (4). Should P_m be less than normal, in consequence of a low cylinder charge or the heating of the intake mixture to the high temperature, P_{max} will be lower in proportion so that the ratio $\frac{P_{max}}{P_m}$ remains unchanged. The engine with reduced volumetric efficiency will not of necessity be heavier as it can be built considerably lighter because the quotient $\frac{P_{max}}{P_m}$ alone is decisive. When the compression

ratio is low, this quotient is generally lower, so that air-cooled rotary engines turn out very well with regard to their H. P. load, in spite of their unfavorable volumetric efficiency and their low compression ratio. (This is certainly also due to the short length of the energy conduit "1" and to the lightness of the accessories A.) This relation shows that aviation engines can be perfectly well built with low weights per H. P. when using prepared fuel mixtures, in spite of the fact that they take in hot air or have extremely hot walls in order to obtain adequate vaporization, or they work with low pressures during the suction stroke in order to obtain adequate atomization.

The combustion type of engine therefore should not be chosen for aviation, or light automobile engine designed for the use of fuels of high boiling point. The latter will always be more difficult to construct on account of its high value of $\frac{P_{max}}{P_m}$ (without taking the heavy accessories into consideration). The aviation engine should rather be selected from the ignition engine class with the best possible atomization and comparatively low compression ratio. With this end in view, a systematic investigation should be made of all the important characteristics of fuels, so that the heavy-oil aviation ignition engine may attain the usual record values which now distinguish the best light-oil ignition engines from all other combustion engines, namely:

Gasoline consumption....180 to 190 grams, 0.42-0.42 lbs. per H. P. hr.

Mean useful pressure.....9 to 10 kg/cm², 128 to 142 lbs. per sq. in.

Load per H. P.....Only 0.8 to 1.5 kg., 1.8 to 3.3 lbs. per H. P.

NOTE I.

The surface tension of the fuel is probably of much greater importance than its viscosity in affecting atomization.

NOTE II.

This is not true should the temperature of the gasoline decrease as the air temperature decreases with increasing altitude. It is probably true, should the temperature of the gasoline in tanks and fuel lines remain the same in flight as on the ground.

NOTE III.

This assumes no heating of the carburetor or manifold.

NOTE IV.

Cooling of the entire weight of air necessary for one pound of hexane 30°C would supply about 193 B. t. u.; whereas, only about 143 B. t. u. are required.

NOTE V.

It is very doubtful that hexane is the principal compotent of any of the present commercial gasolines, except possibly, aviation gasolines.

NOTE VI.

If the values given are for the chemical combining mixture ratio of 15.2 to 1, the manifold pressure assumed is 731 mm. of mercury. Should the manifold pressure be assumed at 760 mm. of mercury, the mixture ratio will be 15.7 to 1.

(Continued on Page 154)

1,500,000 VOLTS

Mr. F. W. Peek, Jr., who was in direct charge of the experiments recently conducted by the General Electric Company at Pittsfield, Mass., is authority for the statement that it is possible to transmit a current of 1,500,000 volts.

In an interview which will appear in the forthcoming issue of "COPPER & BRASS," the Bulletin of the Copper & Brass Research Association, Mr. Peek makes the following statement with reference to these experiments:

"For some time engineers have been able to predict with certainty the corona and spark-over characteristics of high-voltage transmission. These predictions were based on laws of corona established by careful tests made up to about 250 kilovolts (a kilovolt equals 1000 volts), and on spark-over curves established on needle and sphere gaps and line insulators at some-what more than double this voltage. Commercial apparatus has already been built for 220 kilovolt operation.

"It was of great present theoretical and probably future practical interest to determine experimentally if there was a discontinuity in the established laws and curves at a million volts or over.

"Although no deviation was expected, we could not be certain until actual tests were made. We might, for instance, speculate that because of the great length of lightning sparks the air must be relatively weaker at the very high voltages.

"Tests up to about 1,000 kilovolts were made on the elements, entering a transmission line as follows:

(a) The spark-over curve between points showed no discontinuity. The spark-over at 1,000 kilovolts was found to be about 105 inches.

(b) The spark-over curve between spheres 75 centimeteres in diameter showed no great deviation from calculated values.

(c) Tests were made on strings on line insulators and the spark-over voltages were as expected; for instance, a string of eighteen standard suspension insulators arched over at about 900 kilovolts, while a string of twenty-two insulators did not arc over at more than 1,000 kilovolts.

(d) Visual corona tests were made on brass-tube lines 3½ inches in diameter operating single-phase. The corona starting voltage (about 900 kilovolts) checked with the calculated value.

"Brass was used in making the test largely because of the easy manner in which the metal can be spun." Copper would have produced the same result.

"In conducting electricity of such a high voltage, it is necessary to have a conductor with a large diameter to prevent wasted energy. The conductor may be hollow. Copper has always been considered the best of all metals for electrical conducting purposes and we naturally use it."

GET-RICH-QUICK SCHEMES

By James F. Meister, M. E., '05.

Most of us know enough to steer clear of the get-rich-quick schemes where the word "rich" means money or material wealth, but we are still "rubes" when it comes to the matter of acquiring mental and spiritual riches. Yet the principles involved are identical in the two cases.

We are quick to suspect that a gilded brick may not be solid gold throughout, but are easily fooled by the long-winded articles couched in gilded and glittering words offered by "reformers" as a solution to our social and political "problems." But upon close analysis these pretty words and phrases simply form an outward coating for a mass of words and words that have no personal and practical appeal. The reader is told how others should be reformed, but he is not told that **it is more important to first reform himself.**

However, as these articles share a part of the page with advertisements of soaps, flour, motor cars, cameras, breakfast food, etc., the reader's time is not altogether misspent, for, by a few sidelong glances he learns that if it isn't an Eastman it isn't 99 44-100 per cent pure, and that there is a reason why he should ask the man who owns one, as he will eventually, so why not now?

We are too inclined to make a pleasant mental recreation out of these "problems," building up fantastic theories as a child piles up blocks and to no more purpose. As in telling ghost stories to children, we purposely exaggerate and draw on our imagination in order to create more interest.

But we all know that, since God ceated man, the rules and laws of life have stood out simple, clear and distinct. The Bible outlines them and each man's conscience verifies them. One of the favorite indoor sports is to ignore these well-known laws, build up some sort of a monstrous "problem" and then show great intellectual prowess in offering a "solution."

In these days everything is a "problem," but as a matter of fact, we know in our hearts and consciences that God has given us a solution to all these in a few simple rules. It is true that in some cases there may be an honest difference of opinion as to what is right and wrong, but in the great, common conditions of life there is no question as to what is right and as to what is wrong.

As in building a house there may be some question as to the ornamental finish or the interior decoration, but there is no question as to the rock foundation, although the ornamental finish and interior decoration are much more attractive subjects to talk about. So with our "problems," let us begin with the foundation and have it well built up before we quarrel about the details of the finish.

The foundation of the nation is made up of individual citizens and, therefore, our "problem" narrows down to an entirely personal one. It is that of the building of character, and is a slow and unromantic process. As law cannot create character we must give each man an opportunity for study so that he will advance spiritually, mentally and morally. We need to learn how to apply the principles of the square deal to the little, common, everyday acts in the home, in the office and on the street. We need schools, colleges, churches and institutions of various kinds to teach the laws of the ten commandments, the golden rule and the United States Constitution.

But we would rather read about pretty theories than to actually go out and perform some simple, common service, just as we would rather look at a completed cathedral with its beautiful spires and interior decoration rather than to consider the foundation upon which it rests. But we must have a foundation and we must confine ourselve to plain, simple facts. Ages upon ages ago God gave us the plans and specifications. There is no "question" or "problem" about it. It is not possible to get rich **quick** in mental or spiritual wealth.

The great social and economic problems will be solved in exactly the same proportion and extent as each individual develops himself and contributes true and efficient service in whatever line of work in which he is engaged. **Reformation must rest with the individual** and must appeal to his own common, everyday, personal work. Each one must do well his part each day, it matters not how small a part it may be, for he must know that a large work, well done, is only possible by reason of many small tasks well performed. As to "success," he must know that **any work, well done, is a success** in itself, it matters not whether it is large or small, whether it touches the rich or the poor, whether it is prominent or inconspicuous. It is a personal message for the life we are living today. It applies to our social relations in our homes, offices and on the street. It applies to our present work.

Each one has today the opportunity for doing right, for the cultivation of the virtues of kindness, courtesy, patience, fair dealing, honesty and integrity; for showing his faith in God and his confidence in his fellow men; for the cultivation of his mental, moral and physical nature. It is, therefore, **up to each individual to reform himself** and by so doing contribute that much to the nation's foundation of which he is a part. We need no get-rich-quick "solutions." All that is necessary is that each man do his duty—that he act well **his** part.

A labor union will fail, and so will fail a church, a co-operative plan, a profit-sharing plan, a scientific management scheme, or any other of the various methods tried out by capital or labor; it matters not into how much detail it is worked out; unless each **individual** involved shall govern himself by the above principles and so contribute his share toward a firm and solid foundation.

UNIVERSITY NOTES

BUILDING CHANGES AT SIBLEY

Along with the erection of the new chemistry building for the Arts college and the beginning of a new Dairy Hall for Agriculture, come changes in the central part of the Sibley group of buildings, to help make surroundings for the mechanical and electrical engineering students more enjoyable and efficient. Old graduates and present students, with the exception of Frosh and transfer cases, will remember the old days when the "Sibley Dog" reigned as king of the breakfast places for engineers. Shop men, with only one half hour for lunch, are now looking back enviously to the times when they could slip into the cafeteria and get enough to eat without worrying about reporting back on time. Nearly all will recall the front portion of the lower floor of "the Dome" where smoking could be enjoyed along with talk, and work, if that last was necessary.

This year things are taking on quite a different aspect. All of these comforts are not entirely lacking but simply shifted around. The cafeteria alone has departed for good. At first this seems somewhat queer, but better things are in store for the space it formerly occupied. Alterations are being made to turn this large room into a reading or lounging room where more comfortable conditions will exist than did upstairs. It is hoped to make the place on the order of the Barnes Hall lounging rooms, combining their advantages with the additional one of a more convenient location on the quadrangle proper. Upstairs, the Sibley Engineering Library remains as it always has been, but the front portion of that room has been partitioned off and made into executive offices for the college. This is a decided improvement, since it releases the rooms, formerly occupied in West Sibley, for ordinary class work and places the executives and professors of the larger departments in the logical, more convenient, and better centered portion of the building. These offices are in the front of the building rather than the rear as they were up until the change, and where one would expect to find them rather than poked off in an inconspicuous corner. In these changes are seen the first steps in the modernizing of some of the very old and inconvenient conditions present within these ancient halls.

BEQUEST FOR ENGINEERS.

Cornell University and especially future members of its engineering school were unexpectedly but pleasantly made the chief beneficiaries of the will of the late John McMullen of Norwalk, Conn. This wealthy gentleman died in the latter part of the past summer and left the net income derived from his possessions to Cornell with the condition that the money derived therefrom should be used by that University in endowing scholarships in the College of Engineering.

At present the exact value of this appropriation is unknown, but it is estimated that the McMullen estate is valued at close to a million dollars. Of course all of this will not go direct to the engineering schools for a large inheritance tax as well as expenses for settling up the estate, have to be deducted first. However of what remains Cornell receives a goodly share for the gentleman was a widower leaving no children and there were no other heirs. The details as to the amounts of the scholarships as well as the quilifications of those contending for them, were all left to the University to settle. This generous gift comes at a time when it is greatly needed and most sincerely appreciated by all those concerned, not only in the engineering departments but in the entire university group.

THE NEW DORMITORY.

With the initial appropriation of $10,000 made by the Board of Trustees from the Alumni Fund and the acceptance of the architects drawings, the erection of the latest unit of the men's dormitories at Cornell now seems assured as a certainty. As long ago as 1900 the university secured the land now occupied by and surrounding the present Baker Dormitories at the advice of Pres. Schurman. But due to lack of funds and the early death of Mr. Boldt, one of the most interested of the trustees, developement came along slowly until aided by Mr. Baker, Pres. of the National Bank of New York. It is due to his efforts and gifts that the present outlay of dormitories for men with the exception of one of the four buildings, is here to assist the university in its housing problem.

The one building excepted is Founders Hall, put up by the Alumni association recently on the same plot of ground. It is this building which is furnishing the inspiration for the fifth for which the intital release of funds has just been made. The new building is to be placed in a corresponding position to Founders Hall on the north side of the central group known as the Baker group. It is expected that work will be begun in the spring of 1922 and when finished the whole system will appear somewhat in the general shape of an arrowhead with a rather short center bar. Since the Semi-Centenial Endowment Campaign is now finished and conditions look a little brighter for the future it is hoped that this act of the Alumni is the first step towards the much needed new building program. Certain it is that more room is needed by the university to house its annually increasing list of students.

THE PRESENT UNIVERSITY BAND

During the war and for two years succeeding it the organizazion known as the university band was absent from Cornell. Before that time, it is remembered, music was not lacking for the football games or for any other occasions of enthusiasm. But until last year it had not been reorganized, which fact seemed to leave a gap in the doings of the Red and White squads. With the football season of 1920, there finally came the new band; it was decidedly a success, incorporating some forty odd players well distributed in their abilities over the range of musical instruments. The most important playings of the year were at the Dartmouth game held at the Polo Grounds, New York City, at Penn on Thanksgiving Day, and at the Cleveland Alumni Convention the following spring.

This year sees the organization in full swing much earlier in the season than last year. Its first appearance came at the football game with Western Reserve, October 15th. More than 60 members are now playing with the squad, and if possible the results are even better than before. Regulation uniforms of red sweaters, white hats and white trousers add in making the field take on an atmosphere of true Cornell spirit. G. C. Coleman, '95 is the present director, H. D. Wright, '24 drum major and H. O. Merz, '22 manager and leader. All indications point to a most successful year from the viewpoint of good snappy music at Cornell.

THE SEMI-CENTENIAL ENDOWMENT FUND

The Cornell University Treasurer has recently made public the final figures for the results of the Endowment Fund Campaign. The total subscription amount to $6,412,775.72 of which sum about two and half millions have been collected. In addition to these figures an amount of nearly three million more was given for one or another special purposes such as Buildings, Current Expenses, Subscription for the New Chemical Laboratory, Special Endowments, Betterments, etc. This information will soon be in the mails to every subscriber with the purpose in view of collecting as much of the remaining half, or somewhat over, of the pledged amount which still remains unpaid.

CORNELL PRINT SHOP

For many years past it has been the idea of men upon the journalistic boards of various organizations at the University to have a printing association which would be large and amply enough equipped to serve all the college publications. Through the efforts of Sigma Delta Chi, the national journalistic society and in particular R. W. Sailor, '07. and E. P. Tuttle '18, this dream has at last materialized. Before the end of the current year every publication "on the hill" with the exception of the Cornell Daily Sun should be having its printing done by the new corporation which is to take over the Cayuga Press, the job shop of the Ithaca Journal News. This company is to also take on outside commercial propositions along its lines provided it can aptly handle the needs of the college publications, for after all, it is for their benefit that the proposition is being put through. The profits, if any, will be given to the University for use in the publication of educational material under some new plan. This is really the beginning of a fund for the endowment of a University Press.

THE PROBLEM OF FUEL FOR AVIATION ENGINES*

(Continued from Page 151)

NOTE VII.

The mixture ratios for the saturation values of the fuels given in Table I, as computed from published data, are given below:

	Mixture Ratio	Manifold pressure mm. of Mercury
Naphthaline $C_{10}H_8$	12.5	760
	12.9*	785
Decane $C_{10}H_{22}$	15.7	760
	15.0*	738
Ethyl Alcohol C_2H_5OH	8.8	760
	9.0*	774
Benzol C_6H_6	15.0	760
	13.2*	669
Hexane C_6H_{14}	15.7	760
	15.2*	730

*Chemical combining ratios.

NOTE VIII.

Were all temperatures mentioned higher than the saturation temperature of the fuel at the pressures existing, *no* condensation or separation could take place.

NOTE IX.

This is not altogether true, as the engine may be idle at times which precede demands for reliable engine operation, such as when coming out of a long drive and rising from the ground after an unsuccessful attempt to land.

NOTE X.

When H is in kilogram calories per cubic meter and P_m in kilograms per cm² the constant of proportionality is $\frac{427}{10{,}000}$ when H is in B. t. u. per cubic inch and P_m in pounds per square inch the constant of proportionality is, 778 x 12.

ELECTROGRAPHS

The average value of household electrical appliances in California homes that are wired for electricity is $150.

The modern incandescent lamp is said to give about seven times as much light for the amount of electric current used as the first commercial types of forty years ago.

A machine has been invented to remove insects that fly around motion picture lights and spoil a considerable quantity of film. It consists of a wide box, a carbon arc, 2000 candle-power lamps, a funnel, a suction fan and a large net. The insects are attracted by the lights, cremated by the arc, and drawn into the net by the fan.

OBITUARY

E. L. Spencer, M. E. '96, died on January 8, 1918. His late address was 905 East 138th St., New York City.

John O. Dodge, M. E. '04, died on June 26, 1920. His late address was 1449 East 50th St., Chicago, Ill.

PERSONALS

Willard E. Lape, M. E. '77, is Designing Steam Engineer with the Semet-Solvay Company. He resides at 1513 East Genessee St., Syracuse, N. Y.

Andrew H. Green, M. E. '92, is vice president of the Solvay Process Company of Syracuse, N. Y., and is in charge of operation and engineering.

Major Henry C. Nelson, M. E. '92, who served in the late war with the 5th U. S. Engineers, as Major, has since his discharge moved from New York City to Buffalo, where he resides at 195 North Park Ave.

Cornelius D. Ehrtt, M. E. '96, is conected with a Patent Law Office in the Land Title Bldg., Philadelphia, Pa.

Louis J. Hall, '96, who will be remembered by some as coxswain of the '96 Freshman Crew, is now President and General Manager of the Columbian Bronze Corporation of 522 Fifth Ave., New York City. This company makes a specialty of propellors for steamships and other heavy manganese bronze castings. as well as Columbian propellers for small boats.

Lewis A .Shepard, M. E. '97, is president of the Hart Roller Bearing Co., Orange, N. J.

Perley S. Wilcox, M. E. '97, is vice president and general manager of the Tenessee Eastman Corporation, Kinsport, Tennessee.

W. J. Childs, M. E. '98, is prsidetn of the O. J. Childs Co., Utica, N. Y.

Paul P. Bird, M. E. '00, is President of the Boston Sand and Gravel Company. His address is 88 Broad Street, Boston, Mass.

Willis H. Carrier, M. E. '01, with associate engineers has during the past few years succeeded in building up a conspicuously successful business under the name of the Carrier Engineering Corporation. Mr. Carrier himself has remained a consultant of the Buffalo Forge Company and has continued his interest in patents issued in his name and in the activities of associated companies, such as the Carrier Air Conditioning Co. and the Carrier Construction Co. His present business address is 750 Frelinghuysen Ave., Newark, New Jersey.

Warren G. Ogden, M. E. '01, has for the past fifteen years, specialized in the practice of patent, trade-mark, and copyright law. Since his graduation from Sibley College he received the degree LL.B. from Georgetown University in 1905, and has been admitted to the bar of the District of Columbia, Commonwealth of Massachusetts, and the Federal Courts of the First District. Mr. Ogden's office is at 68 Devonshire St., Boston, Mass.

John O. Clark, M. E. '03, is now associated with the Manganese Steel Company of Chicago Heights, Ill. He resides at 244 West Sixteenth St., Chicago Heights.

Lewis E. Meeker, M. E. '04, who is a Telephone Engineer, lives at 39 Overlook Ave., West Orange, N. J.

Walter H. Rastall, M. E. '04, of Dayton, Ohio, has recently been given direction of the Heavy-Machinery Industrial Division, recently established by the Department of Commerce. Mr. Rastall has had much practical experience in marketing machinery, both in this country and abroad, and has recently finished an investigation of the markets for American machinery in the Far East. He will keep in touch with manufacturers of heavy machinery in this country with the idea of rendering any possible service in connection with marketing of their products in foreign countries.

Irving Warner, M. E. '04, has been elected chairman of the Labor Commission of Delaware, to which he has been appointed for five years. His address is 1109 Broom St., Wilmington.

George W. Neilson, M. E. '06, resides at 2511 Hennepin Ave., Minneapolis, Minn.

Ernest O. Billwiller '08, is in business for himself as Contracting Hydraulic Engineer. His office is at 18 West San Antonio St., San Jose, California.

Hans C. Boos, M. E. '10, is now Secretary of the Curtainless Shower Company, manufacturers of shower bath equipment and Kurney Showers. He is married and has a son four years old. His residence is at 1905 Andrews Ave., New York City.

Newton T. Arms, M. E. '11, is with the A. A. Brant Lumber Company of Freehold, N. J.

W. T. Mallery, '21, Captain of the Cornell Tennis Team last year, and Business Manager of the Sibley Journal of Engineering, has recently been transferred from the testing to the manufacturing department of the National Mazda Lamp Division of the General Electric Company, in Cleveland, Ohio. He was recently contendor for the state championship in tennis. His present address is 15333 Richmond Place, Cleveland, Ohio.

Richard E. Lasher, '21, is with the Munson Mill Machinery Company, Inc., of Utica, N. Y., manufacturers of grinding machinery, water wheels, power transmissions, and equipment for feed mill plants, grain and coal elevators, etc.

Paul G. Chase left the Stock and Bond business in 1917, to become Vice President of the Port Arthur Shipbuilding Company. He expects to return to his former business shortly. His present address is 286 River Street, Port Arthur, Ontario.

ENGINEERING ABSTRACTS

Abstractors: Prof. Barnard, Prof. Sawdon, Prof. Upton, Asst. Prof. Pertsch, Asts. Prof. Townsend.

CO-OPERATIVE OFFICES FOR PROFESSIONAL WORK.

By Edwin H. Hewitt, in *Heating & Ventilating*, April, 1921

In the April issue of the Heating & Ventilating Magazine there is described a unique building recently erected at Minneapolis, Minn., for the accommodation of an association of architects in conjunction with landscape and city planning experts, a firm engaged in general engineering practice and a firm of interior decorators. These firms are all separate and autonomous, and yet so equipped as to work separately or together as occasion may require.

The building was opened Nov. 2nd, 1920. It is a five story structure 65 feet front and 110 feet deep and cost $150,000. In addition to the offices, drawing rooms, etc., there is provided a lobby or reception room, a clients' room, a room where contractors may study and figure, special file and storage rooms and fire-proof storage space for original drawing, correspondence, etc. It is said that this community of interest is most delightful and helpful.

W. M. S.

VENTILATION OF PAPER MACHINE ROOMS

By Edward A. Ryan, in *Heating & Ventilating*, April, 1921

This paper describes the difficulties encountered in ventilating paper machine rooms and in caring for the very large quantities of vapor extracted from the rapidly moving paper. The paper comes on the rolls in a saturated condition and must be dry when it leaves the rolls. In 1867 a speed of 100 feet per minute was regarded as phenomonal while at the present time machines are operating at 1000 feet per minute. It has thus come about that in practically the same sized room the quantity of water vapor produced is many times what would have been in the earlier days.

It is stated that while 1.5 B. T. U. per cubic foot of space would be sufficient to take care of the normal radiation loss in the vicinity of Montreal in minus 20°F. weather, the B. T. U. necessary to heat the large quantity of air for ventilation will range from 10 to 20. Different methods of ventilation are discussed and their merits compared in this paper.

W. M. S.

PORTLAND-CEMENT MASONRY FOR POWER STATIONS

By B. S. Murphy.
(In *Power*, July 19, 1921.)

Corrosion is the great enemy of the materials put into the building and maintenance of power plant stations in any part of the world. It cannot be remedied for it comes as a result of conditions which are ever prevalent in such buildings. To a great extent it is due to the sulphur content found in coal which unites with moisture in the air to form a weak acidic destroyer. Then in the boiler and ash room there is always a small amount of ash and coal particles in suspension which settle on exposed surfaces. When moist this produces an alkaline reaction which is equally as fatal to ferrous surfaces as an acidic one; the humidity of the atmosphere is nearly always hovering near the dew point in these rooms so that this is an ever present disadvantage and financial loss.

Until recently firms have been compelled to go to great expense in protecting and replacing the iron surfaces exposed to corrosion; not only expense but serious inconvenience has had to be put up with. Cast iron, wrought iron, and steel have been known to depreciate rapidly yet until not long ago they were used almost exclusively while painting, scraping, and continual replacement went along with them. However, as concrete became more and more known designers and builders were not slow to realize its advantages over iron and steel and placed it where it should be as a **construction** material. But there its use seems to have halted, perhaps due to ignorance on the part of plant operators. Though cement is an excellent material for maintenance repairs and for nearly all stationary constructions, it seems to be little used in these latter fields. It is time for engineers to wake up to its full scope.

Portland-cement mortar is not absolutely immune to corrosive effects yet it disintegrates at so much slower a rate than ferrous surfaces that it is of enormous advantage. The initial cost is slightly greater, yet it lasts so very much longer than other materials that the net gain is more than simply appreciable. This material may be applied in three ways and each has its distinct advantages. For thicknesses up to 1½ inches it is generally best to use it in the "hand plaster" method since nearly always in such cases the application is to be in a place which is difficult to reach except by hand. This is the easiest and least costly of the three ways since no forms are required nor any special machinery. From 1½ inches to 4 inches and sometimes greater dimensions of thickness demand "gunite" which can be more evenly distributed and has

greater density than the hand plastered kind. However, it requires a cement gun for making the application. Most operators find that the purchase of such a piece of apparatus is a distinct advantage since with it the majority of calls for concrete work may be filled. Its uses are unlimited, running anywhere from building structure, erection, alterations, or replacements to lining furnaces. Finally for large piece constructions such as foundations, sidewalks, girder beams, and so forth, the more commonly known process of "casting" in wood molds, reinforcing the concrete with steel bars, is generally employed.

Mr. Murphy describes several instances of repairs of which he is familiar, where cement was tried for the first time and found extremely beneficial and enduring. These repairs are of both major and minor running classes, the feature making this material applicable in the former being its satisfactory stand-up under high temperatures. **Green** concrete, however, should be carefully guarded from heat for the first few days, wetting it several times if necessary to prevent checking due to too rapid evaporation. Separate instances of boiler ash hoppers, coal spreaders, coal hoppers, air ducts, blower scrolls, and even one of a 45° elbow, made of concrete are cited by the author and their reliable service after installation noted. These examples comprise the major running repairs. Those in the minor group consist of blow down tank patches, low pressure water lines corroded at the threads, and repairs to the bottoms of steel tank pits whose sides are still in good condition. These examples of patching are all clearly explained and their repairing described inthe article. From all that was said it appears that the field for concrete work is unlimited and that today sees it only in its infancy.

H. H. D.

RECOOLING THE LUBRICATING OIL FROM TURBINE BEARINGS AND REDUCTION GEARS

By S. E. Derby,

(In *Power*, Aug. 2, 1921.)

For the average turbine installation about 3 per cent of the total power generated is lost as heat in bearings and gears and for installations without reduction gears about 1.5 per cent is lost as heat. Since lubricating oil from turbine bearings and reduction gears is used again and again it must be recooled in a definite and positive manner, as for example, in an oil cooler in which the hot oil is circulated around straight tubes through which cold water flows. Good practice is to circulate the oil through the bearings energetically and then to cool it in an operating temperature of the bearings (by practice found to be about 160° F). How far to cool it may be determined in a manner shown by the author, knowing the heat developed in the bearings in B.T.U. per minute, the velocity of oil circulation, its viscosity at the bearing temperature in Saybolt seconds, and its specific heat. According to the experience of the author an oil temperature drop in cooling of 30° F, from 150° F to 120° F is preferable for stationary service. Under these conditions the oil flow in the bearings is vigorous and a thin oil film is formed that insures a rapid absorption of heat.

Relatively cold oil is not the best for lubricating purposes due to the following explanation. Being less fluid, those particles near the bearings do not move on quickly enough when once heated to be rapidly replaced by more cold ones. Most of the oil does not get into contact with the bearings, therefore, and they become overheated. They may even become so hot that heat is conveyed by conduction to those few particles in contact with them. As a result a comparatively small portion of exceedingly hot oil mixes with the remaining larger quantity of cold oil, and there is established at the outlet of the bearing a low oil temperature which is by no means indicative of the temperature of the bearing itself. In efficient lubrication the bearing is kept cool not by establishing a low bearing outlet oil temperature, but by bringing into contact with the bearing surfaces as many particles of oil per unit of time as possible. Because of this disadvantage of relatively cold oil and the fact that specific heat decreases with the temperature it is better to use a large quantity of oil recooled through a small temperature range than a small quantity cooled through a large range. In cooling the oil the temperature of the cooling water can be closely controlled by regulating the amount of water passing through the cooler. The temperature drop in the oil in the cooler decreases with the temperature of this oil at its entrance to the cooler, due to the fact that as its temperature diminishes the oil becomes thicker and more viscous and its movement along the cooling surface becomes sluggish. For this reason cooling is retarded.

The heat transfer rate in the oil cooler (the heat in B.T.U. transferred per hour per sq. ft. of cooling surface per degree F. mean temperature difference between oil and water) depends on the velocity and viscosity of the oil, the velocity of the water, arrangement of the cooling surfaces, etc., which means that it is practically impossible to use any fixed heat transfer rate, in designing an oil cooler. Increased velocity of circulation increases the heat-transfer rate, but also increases the friction drop of the oil and water. However, since a high heat-transfer rate decreases the amount of cooling surface required, modern efficient oil coolers are designed with as high a velocity of the oil and water as is possible without causing an excessive drop due to friction. There is a practical limit beyond which it is not advisable to increase the water to oil ratio (weight of water circulated per unit time to weight of oil circulated per unit time), since the

increase in temperature drop is not at all commensurate with the increase in quantity of circulating water. For example, in one case an increase in the ratio twelve times only produced an increase of about twice the temperature drop. The author concludes his article with a description of a typical outlay of the lubrication system of both a marine turbine installation and a stationary turbine installation. H. H. D.

DIRT PLUS STATIC AS CAUSE OF TURBO-GENERATOR FIRES

By D. D. Higgins, *Chief Electrician, Northwest Station, Commonwealth Edison Co.*

(In *Power*, Aug. 9. 1921.)

From widely separated points cases have been reported of generators being burned out during the winter months when the internal temperatures were low and the load only normal. No definite diagnoses could be made. The presence of dirt upon the high voltage coils of generators was looked upon by many with suspicion but nothing definite could be decided due to all evidence being destroyed in practically every burnout case on record. Armature coils of large turbo-generators usually are not accessible for frequent cleaning, and owing to the great quantity of air required for cooling, a deposit of dirt developes. This "dirt" comprises the solid matter of the air in the immediate vicinity of the air-washer intake, if there is such an instrument used, and near the coils of wire themselves. Oil, and dust, and miscellaneous power plant dusts will be deposited in the pockets of the armature and field structure, in the small places between the backs of the coils and anchor rings. How dangerous this collection of dirt may be, was determined by the author in a series of tests upon representative samples. Being so seldom cleared off, in even present day practice, it constitutes an ever menacing danger wherever static sparks may be released or resistance heating developes an incandescence (even for just a moment) which might ignite this inflammable material. This applies to air cooled transformers, high voltage cable lines, etc., equally as well as to generators.

Some of the discoveries made in the tests were astonishing—all of them were of major importance. The dirt was placed upon a concrete floor and brought to within about an eighth of an inch of a specially prepared cable which reproduced as nearly as possible conditions in the armature of a generator A static spark not only lit the dirt but served to fan the blaze once it was started. Small particles were attracted to the cable, then upon being charged with like polarity were repelled, travelling six or eight inches, and if conditions were favorable starting other fires. When cold the dirt proved an excellent insulator but like carbon with its negative temperature coefficient its resistance dropped when heated. Next a pair of direct current leads with 110 volts between them and carrying a current of 5 amperes were put in contact, buried in the dirt, and then quickly separated. The dirt was instantly lighted although the ends of the leads were nearly an inch apart. Of course this dirt on windings is not a hazard so long as the temperature remains low, but around electrical apparatus one can never tell when something may happen to produce intense heat at the weakest spots.

A related topic is the value of air washer installations in the regulation of moisture and relative humidity of the atmosphere surrounding the generators. They are of great value if properly controlled, but become a danger if neglected or ignorantly managed. Especially this is true in cold weather. There must be enough moisture (about 95% humidity) in the surrounding air so that a good ground may be secured and the static developed drained off uniformly. In winter this is a harder task than ever. If the static electricity is allowed to collect and build up, a spark will soon result and perhaps start a burnout. But there must also not be too much moisture for if the 100% mark is reached precipitation and accumulation on slightly cooler points may easily occur. Often generators are shut off. Consequently they are apt to be a few degrees colder than intake air when started up again. If this air contains water vapor or fog, the deadly water may collect at some unobserved point and the well known dangerous results occur. A graph of the quantity of water present in air under various conditions completes the well treated article upon this subject. H. H. D.

CUTOUTS FOR MOTOR PROTECTION.

By Edgar P. Slack.

Assistant Electrical Engineer, Underwriters Laboratory

In *Power*, Aug. 15th., 1921.

The object in having cutouts of one kind or another in an electrical circuit is primarily as a safeguard against the great heat developed when too much current flows through a given conductor. If subjected to a heavy load an electric motor responds drawing more amperage from the supply line than it normally would, which heavy current heats the motor windings with the result of a burning out of the motor or at least a shortening of the life of the insulation. Cutouts are employed to protect protions of the line as well as the motors themselves; there are three varieties known in common practice e. g. the ordinary running fuse, thermal cutouts other than fuses, and the circuit-breaker.

Certain conditions, however, do not call for cutouts. For instance for motor rated at two horse power or under the fuses protecting the main and subsidiary lines are considered adequate. Motors for other than "continuous" rating purposes such as elevator or crane motors, which are used off on thereby obtain a chance to cool, may be installed without cutouts. Likewise squirrel cage or similar motors

whose running fuses are cutout of circuit during starting are also considered sufficiently protected during the starting period by the line fuses. There should be no confusion between the fuses installed for protecting a line and those for protecting the motor. The capacity of the first is determined by the size of the wires composing the line, that of the second by the capacity of motors itself. Sub mains are fused where they join mains, and branch circuits where they join sub-mains, the size of the fused in each case being only slightly larger than the carrying capacity of the line to be protected. The same holds for motors.

As to the rules which the National Electrical Code lays down with respect to these cutouts. In the first place all continuous rated motors of over two horsepower must be protected in an acceptable manner. Inspections are made every so often and offenders prosecuted by law. If fuses or other thermal cutouts are used their rated capacity must not be above 125% of the name plate current rating of the ampere protecting fuses. If a circuit breaker is used it must carry a continuous curren of at l ast 110% of the name plate current rating due to unavoidable and insignificantly dangerous fluctuations of the load which cannot be helped. However the circuit breaker must not carry more than 160% normal load if of the instantaneous type nor more than 125% if of the reduced degree of protection offered in the cases calling for time limit circuit breakers (when great overload for **short** period of time does no harm). Thus a 100 amp. motor calls for a circuit breaker which must carry at all times 110 amperes but not more than 160 amperes if instantaneous or 125 amperes if time controlled. This code has proven to be of tremendous importance as a safety factor in the electrical world.

SAFETY PRECAUTIONS IN THE OPERATION OF LARGE TURBINES.

In *Power*, Sept. 6th., 1921.

Since vibrations in the rotating element of a turbine may be called the primary cause of nearly all turbine troubles, these vibrations and their remedies are of high importance for safety and economy of operation. They may be divided into vibrations of primary and of secondary character. Those of the first class embody as their cause faulty shop work or erection; deflection of spindle; excess bearing clearance; improper fitting of bearing in housing; or admitting air through glands. Secondary vibrations may have as their origin: rubbing or loss of blades; local heating due to rubbing of packing or sealing rings; wedging of spindle by fused metal; distortion of cylinder casing by expansion of steam pipes; lack of rigidity in the motor due to improper fitting of component parts; warping of blade rings, etc. Each of the above cases is treated in great detail in this article, the cause, remedy, and a practical method of procedure for repair being clearly brought forward to the readers attention.

In consideration of these vibrations and their causes an outline is submitted of the steps to be gone through in the proper starting of a large turbine.

(1) Start the auxiliary oil pump, bringing oil to the operating pressure.

(2) If the throttle valves are so constructed that they do not respond to the overspeed trip unless fully opened, test the automatics by tripping the overspeed device noting carefully any tendency to stick or act sluggishly. If all valves respond to the overspeed when throttles are a short distance off seat then trip by the overspeed.

(3) Bring the circulating pump to speed with full capacity through the condenser.

(4) Operate the dry vacuum pump at quarter speed with the dry air line closed to condenser.

(5) Have the hotwell pump running with suction and discharge valves open as soon as sufficient water is in the hotwell to seal the pump.

(6) Have the field current on generator with some positive indicator denoting the fact.

(7) Have the seals turned on the glands.

(8) Start the rotor turning and shut off steam immediately by closing the throttle by hand if it will not respond to the overspeed trip.

(9) Note all indications of unusual conditions and fix.

(10) When all is correct steam is again turned on and vibration trouble noted and fixed (If any).

(11) Bring rotor to speed.

In shutting down the following rules should be abided by as nearly as possible.

(1) Start auixiliary oil pump five minutes before shutting down time.

(2) When load is thrown off the engine close all valves and open vacuum breaker by tripping the overspeed device. If valves stick, fix immediately.

(3) Air and hotwell pumps are then shut down; Gland seals shut off when pressure in condenser rises to atmospheric.

When spindle comes to rest shut down auxiliary oil pump and shut off oil field current.

In connection with the above a discussion of the lubrication requirements of a turbine follow. Oil must be supplied to the bearings under a pressure of 6 to 8 lbs. lest the shaft touch the bearing metal under load, since this metal is so soft. The oil is subjected to a combination of impact, pressure, and velocity and when accompanied by even as small an amount as 1% of moisture emulsification results causing the breakdown of the oil and rendering it practically useless. Therefore turbine oils should be thoroughly tested and that one selected for use which withstands best the emulsification tests. The article is concluded with a description of a relatively simple apparatus for making these tests.

H. H. D.

HANDLING THE RIVER.

By L. N. Devendorf. In *Power*, Aug. 23rd., 1921.

The modern hydro electric plant should use, wherever possible to increase the available load, every bit of increase in steam flow which might occur from freshets, local floods etc. Most of them are designed with this possibility in mind and likewise the one of low water as well as that of high. Reliable prediction of stream flow a day or so ahead is of very great importance. Of the two cases, flood or low water, it has perhaps greater value in the latter. The greatest enemy of a water power plant is ice because of the uncertainty of everything connected in any way with it.

Unless the pond or reservoir above the dam is free from currents or swift motion of any kind sheet ice will not form immediately. What happens is that the ice forms in minute crystals which in still water would rapidly unite to form a solid sheet but which, in the case of rifts and rapids are churned about so that the union does not take place so rapidly. These crystals are extremely near the freezing temperature however, and immediately upon touching anything, such as a metal bar or even the bottom of the river, give up their last bit of heat and assume the state of a slushy half solid substance. This is known as anchor ice and gives a great deal of trouble where found, from the first cold clear night until everything is frozen up tight for the winter. In still water the sheet ice forms almost immediately and little annoyance is felt from this source. Here as well as in nearly every phase of hydro electric power plant overating local conditions govern everything and what might be "one man's meat is another's poison."

With the coming of winter the task of keeping one or more of the waste gates and the intake sluice to the turbines free from ice becomes a regular part of the routine. "Firing" gates is of course unsafe if their material is wood; likewise the use of gasoline or kerosene torches. Either of these methods shortens the life of a metal gate considerably. The best process for all around cases is thawing by steam. Although a little expensive in initial cost of installation of the apparatus, it is the safest, most economical, and most satisfactory method.

In spring or late winter the danger of the thaw, breaking up of the ice, and resulting high water becomes imminent. Here is where prediction has considerable value. Nothing should be left undone in preparation for this annual trial. Flashboards should be removed from the spillways lest a jam result in an abnormal rise of water with its flood danger. All openings in the tail race should be closed solidly with iron covers, the joints being sealed with rubber gaskets. Drains inside the buildings should be inspected and everything made ready to carry off the water which might enter cracks. To take care of floating ice the following implements are necessary: pike poles, rakes, ropes, ice handling tools, dynamite, means of handling large logs that may be found in the racks, a good substantial flat bottom boat and a life preserver. Knowledge of artificial respiration often is useful. Spiked shoes and safety belts are not to be laughed at, in dangerous work around a dam. Upstream above the dam ice breakers should have been built slanting upward on the upper surface in a downstream direction. A 30° elevation is about the right slant and these wooden breakers should stand about 6 to 8 feet above water on the down stream side. The second line of defense is a boom, or masonry wall with submerged arches, installed a few feet from the racks. Unless the station is adequately protected in every way, it is best to shut down the unit entirely during the breaking up. However, this is the last thing to be thought of in all cases, since continuous operation is imperative in nine out of every ten plants.

When summer comes low water has to be met. The main effort now is to pass the entire flow of the stream through the turbines at an efficient head and efficient gate openings. Of course this cannot always be done due to need of plants further downstream, and then hydraulic efficiency and economy of so little importance during floods, has to be rigidly practiced. Usually continuous operation is called for, even when there is not sufficient water to operate this plant at efficient gate openings; but if not the plant should be operated at the gate opening that gives the highest efficiency, usually between 0.7 and 0.8 of full opening, even if it cannot be operated in this way more than two or three hours a day.

In every problem that arises the engineer must always think further back than the dam and station, think always of the factilities for increasing or decreasing the load, what would happen if he had to shut down entirely or the results of partial lay off of his unit in the system.

H. H. D.

ELECTROGRAPHS

New Zealand plans to expend approximately $100,000,000 for hydro-electric power development. The program is already under way.

Fifty thousand electric dishwashers, 60,000 electric ironing machines, 100,000 electric sewing machines and 700,000 electric washing machines were, it is estimated, sold in this country in 1920.

A group of Spokane, Washington, men who are engaged in various phases of the electrical industry have organized the Spokane Electric Service League, the objects of which are to promote the growth of the electrical industry in all its branches, the co-ordination of effort in rendering better electrical service to the public, etc.

1921 *greets* 1925

"FEELING blue?" asked the grad of four months' standing. "Everything's new and strange, isn't it? I myself know how that feels. At my job in the electrical works I'm a freshman over again—like you, a little frog in a big puddle.

"Not so easy, getting on to the ropes. Makes a fellow impatient for the time to pass. You're anxious to get the upper hand over your work, you want to make the team, you want to clean up in general.

"Well, it can't be done all at once. But getting off to a good start is half the game. Just pick out what you want the most and go after it hard.

"Tackle your obstacles—pretty tough now but after you've downed these you'll find the going easier. Look on each week as a yard line you are crossing.

"See how every gain, every problem you get the best of, is important—not for itself but because it is a necessary part of the bigger drive that gets you down the field. Just keep plugging, with your heart in the game, and you'll make your touchdown.

"Pretty good advice, isn't it? Guess I'll take it myself!"

Published in the interest of Electrical Development by an Institution that will be helped by whatever helps the Industry.

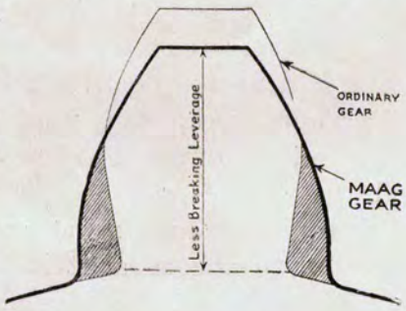
Western Electric Company

Many of the men who started with this Company as "freshmen" are now, as its "seniors," filling important executive positions in America, in Europe and throughout the whole world.

Their teeth are stronger at the base if thy're

MAAG GEARS

COMPARE these tooth diagrams of a Maag Gear and an ordinary gear. At the base of the tooth, where other gears most often fail, Maag gears are widest. This "strongest-at-the-base" tooth is typical of all Maag Gears—large or small—and is the fundamental reason for Maag tooth strength and Maag Gear endurance. It means the ability to carry greater loads than ordinary gears will take.



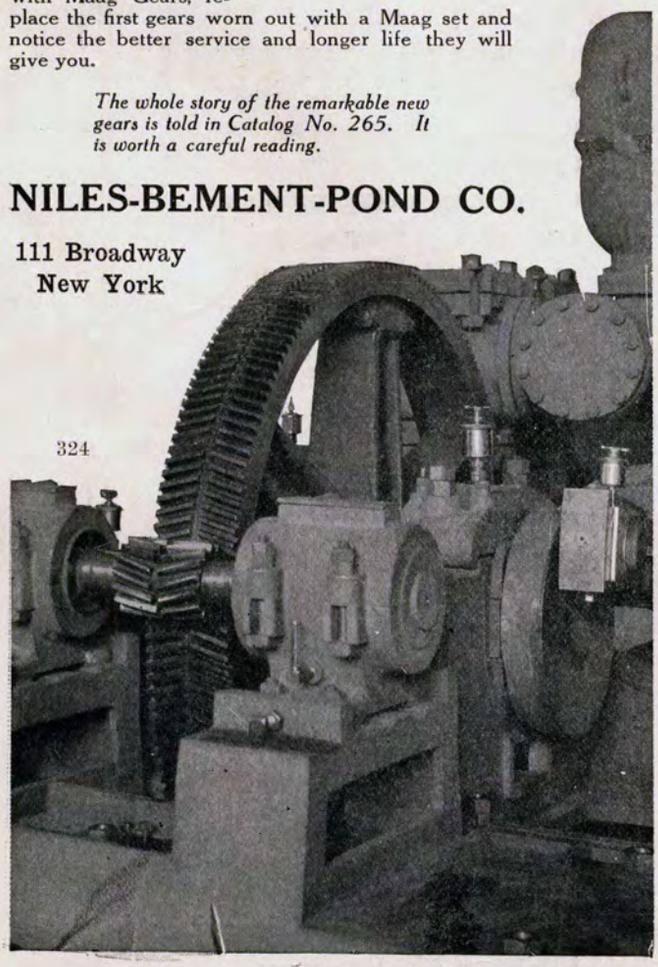
We use Maag Gears on the heaviest machine tools we build. We know they are stronger and longer wearing than any other gears we've ever tried.

You need such gears on your mine equipment. If the machinery you buy now isn't equipped with Maag Gears, replace the first gears worn out with a Maag set and notice the better service and longer life they will give you.

The whole story of the remarkable new gears is told in Catalog No. 265. It is worth a careful reading.

NILES-BEMENT-POND CO.

111 Broadway
New York

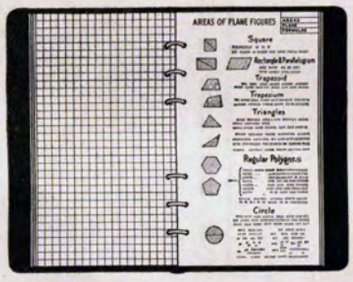


IF you know what it is, get what you want now from

Sibley Journal of Engineering

L E (L E A F & F A C T S) X

IF you don't, let us show you what you need - come to-day to basement of West Sibley



Broad Faces Lessen Wear

Any piece of machinery operating at high speed or under stress of continuous load can be protected against wear by a broad bearing surface.

Recognizing that constant oscillation causes wear, we have built the segment with an unusually broad face, and with pinions with corresponding width in

AMERICAN GAUGES

To insure the utmost in durability, American Gauge Segwhile both segment and pinion shafts revolve in wear-resistment is, furthermore, made of an extra-hard bronze alloy, ing bushings of phosphor bronze.

Under conditions which soon rack ordinary gauges to pieces, American Gauges stand up defiantly for years.

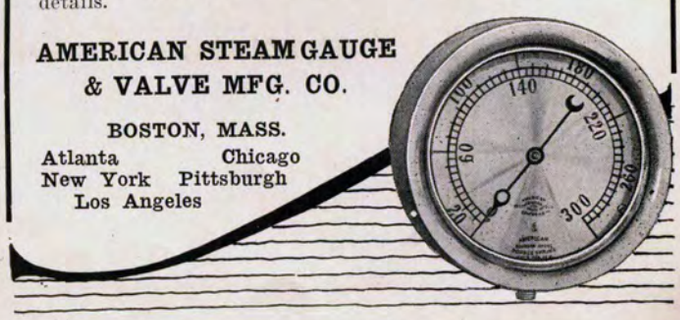
The *individually hand-calibrated* dial, insuring *accuracy*, is another feature of American Gauges that you cannot afford to overlook.

Write today for our gauge Catalog No. 70—giving full details.

AMERICAN STEAM GAUGE & VALVE MFG. CO.

BOSTON, MASS.

Atlanta Chicago
New York Pittsburgh
Los Angeles



Be a Modern Samaritan

A million consumptives are falling by the wayside! They need your helping hand.

You are a modern Samaritan when you Christmas Seal your Christmas mail. Through the accumulation of dollars received from the sale of these seals nurses and physicians are enabled to give their services to millions of stricken people throughout the United States.

Express the Yuletide spirit—constructively.

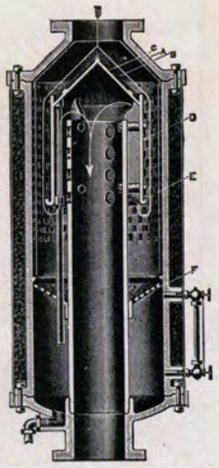
your Christmas Seal Christmas Mail

The National, State and Local Tuberculosis Associations of the United States

Sweet's Steam and Oil Separators

OPERATION

The accumulated moisture around the walls of the steam pipe is caught by the upper edge of cone A and carried down back of a lining to the water chamber. The current of steam entering the Separator impinges upon the conical surface composed of solid plate C covered with sieve B, through which water may freely pass, but from which it cannot readily escape. Passing through the sieve and depositing on the solid surface of the cone C this water is carried by conductors to the water chamber. By means of the cone the column of steam is changed to an annular ring, which is comparatively thin, even while the full era of the pipe is maintained. The steam upon the outside of this ring comes in contact with the lining of the shell, which has a sieve of the same character, as at B, and which catches and entrains any water which may be contained in that portion of the current. There is also provided a lip at lower edge of inverted cup, which leads all the water that may adhere to its surface down through the conductors to the water chamber. The current of steam passes through the passage indicated by white lines, and is subjected to a whip-snapping action, which will throw off any moisture that has not been caught by the surface over which it has passed. The diaphragm F prevents the steam from picking any water out of the water chamber.



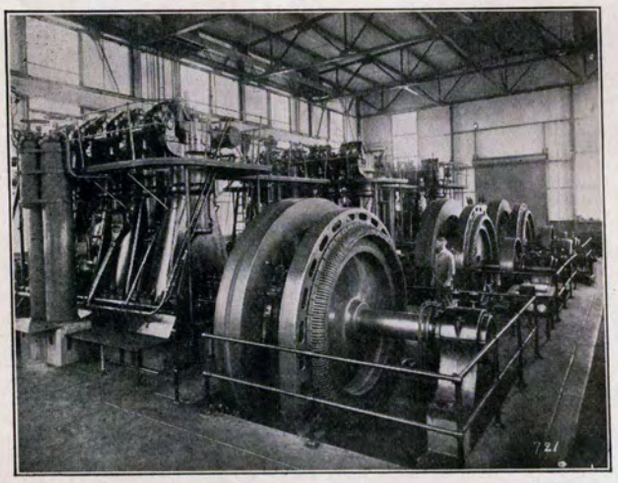
VERTICAL STYLE

Made in all styles. Send for Catalog.

DIRECT SEPARATOR COMPANY

Corner Fayette and Geddes Streets

SYRACUSE, N. Y.



Diesel Oil Engines

Low fuel cost on account of the small amount of fuel used. Low attendance cost on account of the elimination of boiler room labor and the handling of coal and ashes. Low maintenance due to the elimination of boiler cleaning and repair.

Sizes available—Stationary type—100 to 2500 B.H.P.—All four cycle.

The above station has been operating over four years on 24-hour service and is now feeding into transmission lines and delivering power under present conditions at less than one-half cent. per K.W.-hour.

McINTOSH & SEYMOUR CORPORATION

MAIN OFFICE AND WORKS

AUBURN, N. Y.

The introduction of the first Starrett Tool more than forty years ago brought to the metal working trades a new standard of accuracy in precision tools. Today the Starrett tradition of dependable accuracy is upheld by 2100 Starrett Tools.

Get Catalog No. 22 "B H" describing and illustrating 2100 Starrett Tools. Copy free on request.

THE L. S. STARRETT COMPANY

The World's Greatest Toolmakers
Manufacturers of Hack Saws Unexcelled

ATHOL, MASS.

Starrett Tools

42—226

GOOD LIGHTING OF INDUSTRIAL PLANTS SECURES SAFETY AND EFFICIENCY.

The Code of Lighting for factories, mills and other work places of the State of New Jersey makes excellent recommendations of daylight for the proper lighting of industrial buildings.

Adequate daylight facilities through large window areas, together with light, cheerful surroundings, are highly desirable and necessary features in every work place, and they should be supplied through the necessary channels, not only from the humane standpoint, but also from the viewpoint of maximum plant efficiency.

Importance of Daylight.

The unusual attention to gas and electric lighting in factories, mills and other work places during the past few years; the perfection of various lamps and auxiliaries, by means of which an improved quality and quantity of lighting effects are obtained; and the care which has been devoted to increasing the efficiency in various industrial apparatus—all go to emphasize the many advantages and economies that result from vital and adequate window space, as a means for daylight in the proper quantities, and in the right direction during those portions of the day when it is available.

Three Considerations.

Three important considerations of any lighting method are sufficiency, continuity and diffusion, with respect to the daylight illumination of interiors. Sufficiency demands adequate window area; continuity requires (a) large enough window area for use on reasonably dark days, (b) means for reducing the illumination when excessive, due to direct sunshine, and supplementing lighting equipment for use on particularly dark days, and especially towards the close of winter days, (c) diffusion demands interior decorations that are as light in color as practicable for ceilings and upper portions of walls, and of a dull or matt finish, in order that the light which enters the windows or that which is produced by lamps may not be absorbed and lost on the first object that it strikes; but that it may be returned by reflection and thus be used over and over again.

Diffusion also requires that the various sources of light, whether windows, skylights or lamps, be well distributed about the space to be lighted. Light colored surroundings as here suggested result in marked economy, but their main object is perhaps not so much economy as to obtain results that will be satisfactory to the human eye.

Requirements for natural lighting:

1. The light should be adequate for each employe.
2. The windows should be so spaced and located that daylight is fairly uniform over the working area.
3. The intensities of daylight should be such that artificial light will be required only during those portions of the day when it would naturally be considered necessary.
4. The windows should provide a quality of daylight which will avoid a glare, due to the sun's rays, and light from the sky shining directly into the eye, or where this does not prove to be the case at all parts of the day, window shades or other means should be available to make this end possible.

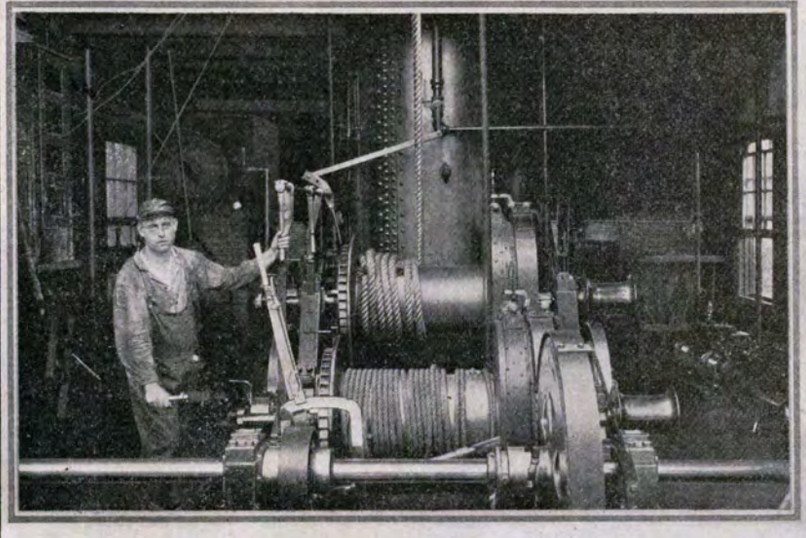
As will be noticed in the above recommendations, large windows and proper diffusion of daylight are urged, in order to meet the demands of daylight lighting.

Shades may be eliminated and most efficient lighting obtained by the use of Factrolite Glass.

If interested in the distribution of light through Factrolite, we will send you a copy of Laboratory Report—"Factrolited."

MISSISSIPPI WIRE GLASS CO.,
220 Fifth Avenue,
St. Louis. New York. Chicago.
No. 7.

LIDGERWOOD HOISTS



STEAM — ELECTRIC
GASOLENE

For all
Contractors' Uses

They do the work

Illustration shows pile driver at work on piers for Beard's Estate at Erie Basin, Brooklyn, N. Y.

Contractor, ALLEN N. SPOONER, & SON, INC., New York

DERRICKS—PILE DRIVERS—CABLEWAYS

OUR ENGINEERS ALWAYS AT YOUR SERVICE

Catalogues upon request

LIDGERWOOD MFG. CO., 96 Liberty Street, New York

BRANCHES

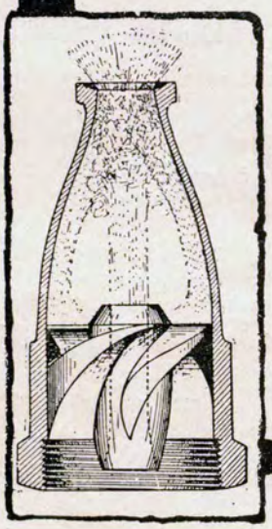
Philadelphia Pittsburgh Chicago Cleveland Detroit Charleston, W. Va. Los Angeles Seattle London, Eng.

SPRACO

THE SPRACO SYSTEM

FOR COOLING CONDENSING WATER

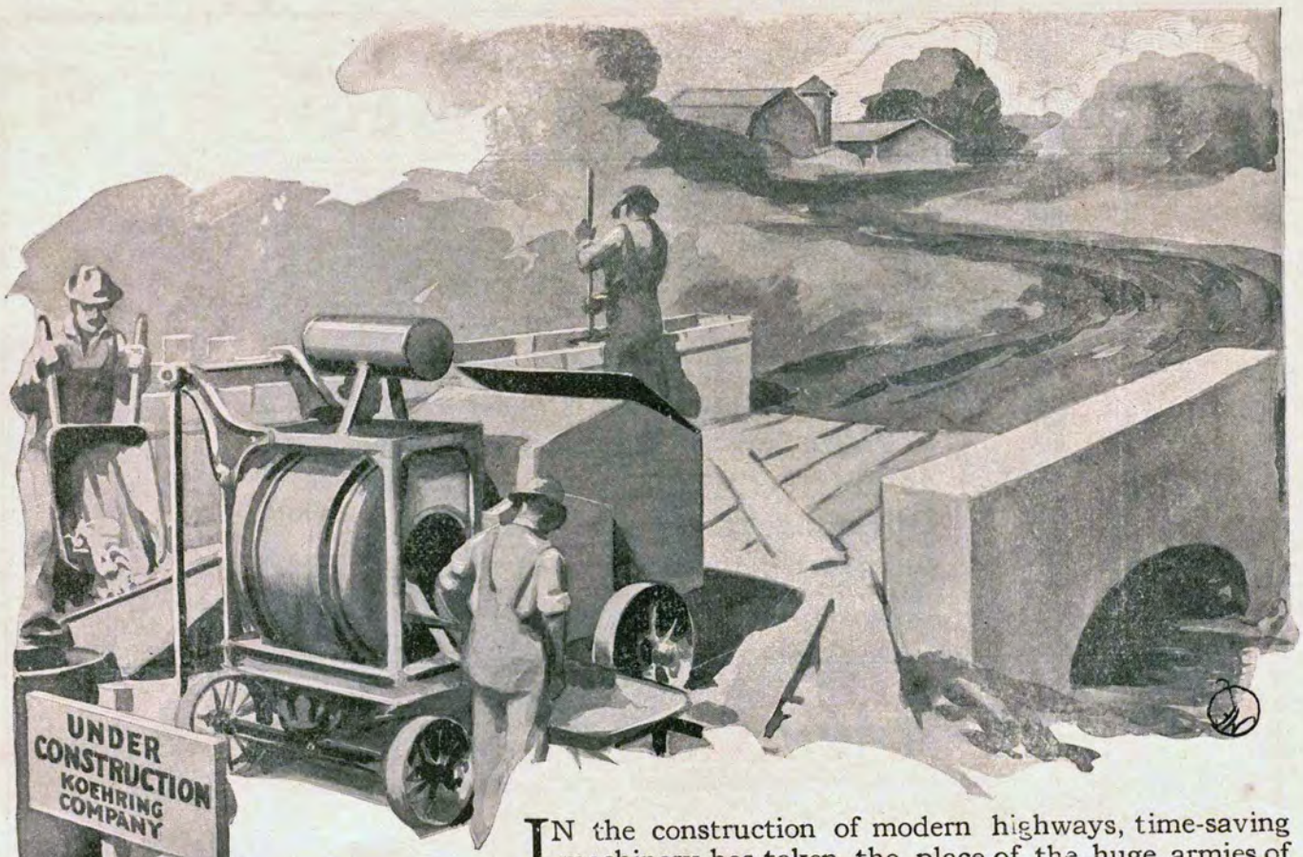
enables a power plant to be operated condensing and thereby obtain maximum efficiency, with very little natural water supply available. The illustration herewith shows a plant located on a stream which has no flow during the hot summer months and still good vacuum is obtained by means of the SPRACO COOLING POND.



SPRAY ENGINEERING CO. Boston, Mass.

Manufacturers also of Spraco Air Washers, Spraco Paint Guns and High Temperature Cement Sprayers, Spraco Nozzles, Vaughan Flow Meters, Etc

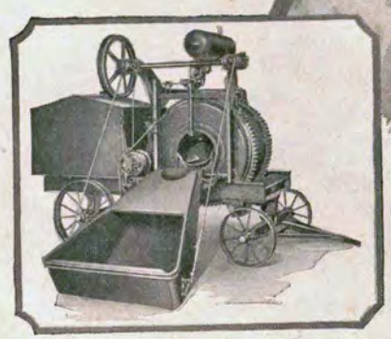
SPRACO PRODUCTS



IN the construction of modern highways, time-saving machinery has taken the place of the huge armies of artisans which, by brute strength accomplished the road-building of the Egyptians and Romans.

The nerve center from which modern highway building radiates is the concrete mixer. Without it, the present wonderfully developed system of paved roads would be only a chimerical dream.

The concrete mixer has made possible the economical building of culverts, the rapid construction of bridges and approaches, the placing of concrete foundation for brick and other two-course pavements, and—probably its greatest achievement of all—the construction of the thousands of miles of smooth, hard and enduring concrete roads reaching across all sections of the land.



There is a particular type of concrete mixer for each of these phases of road engineering.

Culvert construction demands very much different equipment from paving construction. An average culvert requires the mixing of only a few cubic yards of concrete. Wherever, along the road to be paved, a cross ditch or sharp hollow happens to lie, there a culvert must be built.

To meet these conditions the Koehring Dandy Light Mixer is used. It is sturdy and substantial, yet light in weight and easily portable from culvert to culvert in quick time by truck or team.

The Dandie's quick mobility arises in part from its small size; its capacity of 4 and 7 cubic feet of mixed concrete are just right for the well planned culvert project.

KOEHRING COMPANY

Manufacturers of Concrete Mixers and Locomotive Cranes

MILWAUKEE, WISCONSIN

KOEHRING

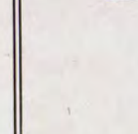
Remington Portable Typewriter

You know the standard Remington typewriter. You find them in almost any business office. Remington typewriters stand the wear and tear of business. The Portable has the standard keyboard and perfect writing qualities of the larger machine. We have an easy payment plan for students.

Cornell Co-op. Society

MORRILL HALL ITHACA, N. Y.

DAMASCUS



THE WATCHWORD IS ECONOMY

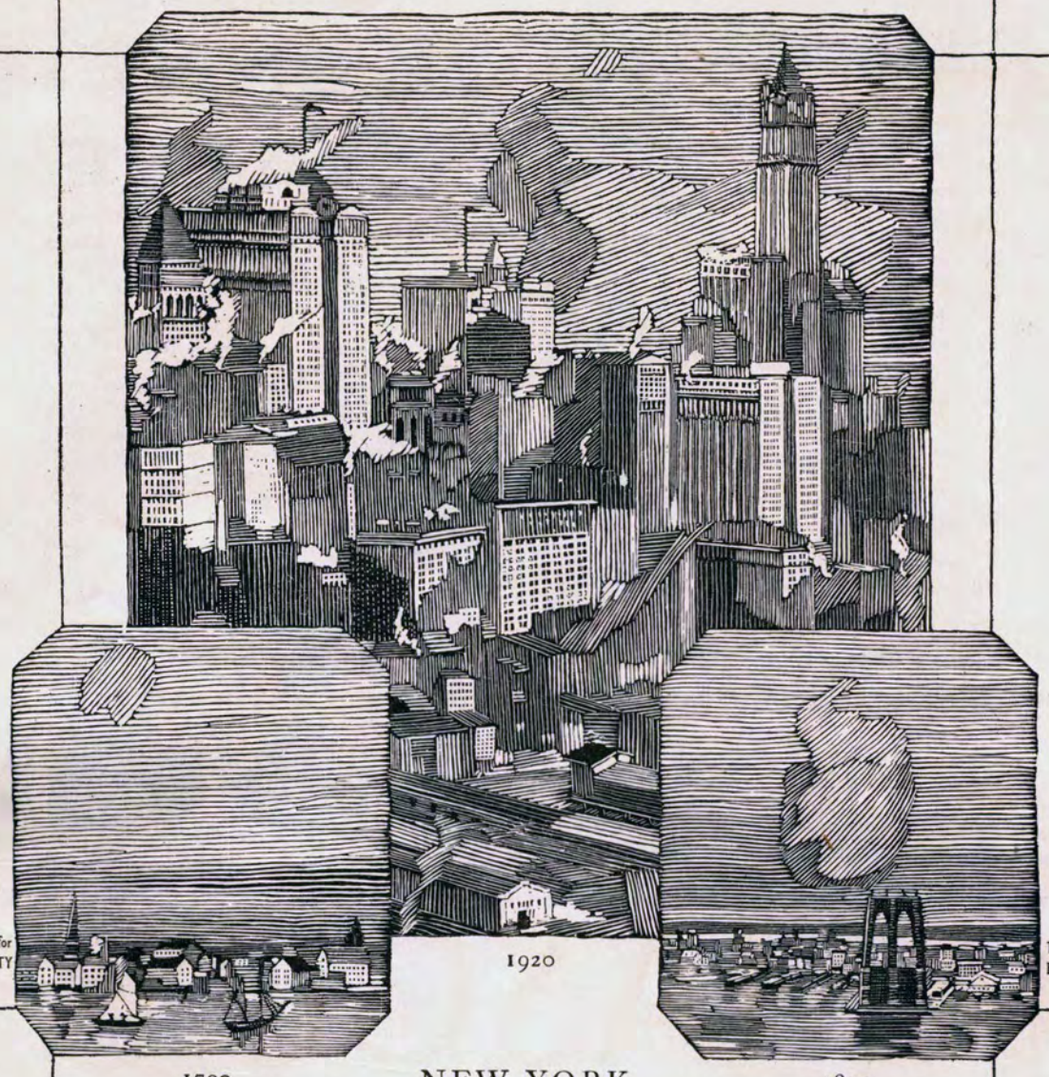
in every business now more than for a long time. Utmost service is required of every mechanical appliance. This can be obtained only by installing the best.

Damascus Bearings are sold on the principle that what lasts longest is cheapest. They reduce the number of renewals to a minimum.

Your inquiries solicited.

DAMASCUS BRONZE CO.
PITTSBURGH

Please mention THE SIBLEY JOURNAL—*it identifies you—it helps the* JOURNAL



Otis
The WORLD'S WORD for ELEVATOR SAFETY

1790 1920 1870

NEW YORK

Otis
The WORLD'S WORD for ELEVATOR SAFETY

Most of the famous buildings of the world are equipped with Otis Elevators

THE WOOLWORTH TOWER—the tallest office building; the Equitable—the largest; the Singer Building—in fact most of the buildings that make up the best known sky line in the world, are equipped with Otis Elevators.

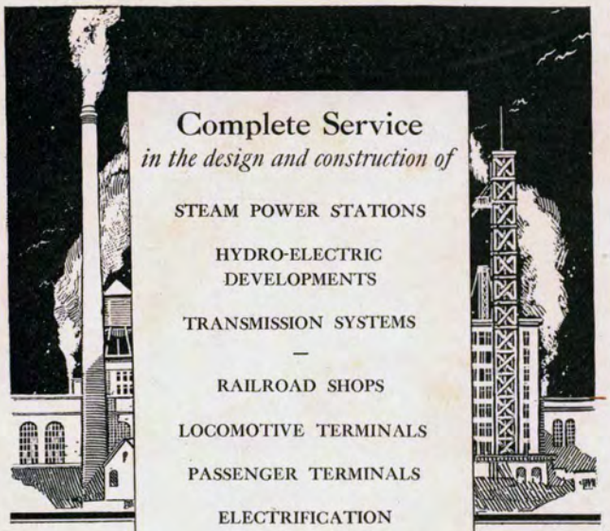
Few people realize the amount of wealth of Manhattan Island that is due to the creation and development of modern vertical transportation by the Otis Elevator Company. New York City could not grow wider hemmed in as it was by the two rivers and the bay. It *had* to grow skyward.

And now, the Otis Elevators in New York City carry daily more than twice the number of passengers carried by all the traction lines of New York—subway, surface, elevated and railroads.

Nothing short of a book would adequately tell the story of Otis in New York alone.

OTIS ELEVATOR COMPANY

Offices in all Principal Cities of the World



Complete Service
in the design and construction of

STEAM POWER STATIONS

HYDRO-ELECTRIC DEVELOPMENTS

TRANSMISSION SYSTEMS

—

RAILROAD SHOPS

LOCOMOTIVE TERMINALS

PASSENGER TERMINALS

ELECTRIFICATION

—

INDUSTRIAL PLANTS OF EVERY CHARACTER

DWIGHT P. ROBINSON & COMPANY
INCORPORATED
ENGINEERS AND CONSTRUCTORS
125 EAST 46TH STREET
NEW YORK

CHICAGO YOUNGSTOWN DALLAS LOS ANGELES MONTREAL

THERE ARE
KENNEDY
VALVES
for all services.

Kennedy Valve users have a choice of over 500 distinct types and sizes from which to select exactly the right one for any given duty.

Waterworks, power plants, pumping stations, gas works, sugar mills, acid and alkali plants, and industrial plants of every type have found Kennedy Valves always reliable and free from maintenance expense.

THE KENNEDY VALVE MFG. CO. ELMIRA, N.Y.

BRANCHES:
NEW YORK: 95 John St. BOSTON, 47 India St.
CHICAGO: 204-8 North Jefferson St.
SAN FRANCISCO: 23-25 Minna St.
EXPORT OFFICE: 95 John St., New York

222

HIGGINS'
Drawing Inks
Eternal Writing Ink
Engrossing Ink
Taurine Mucilage
Photo Mounter Paste
Drawing Board Paste
Liquid Paste
Office Paste
Vegetable Glue, Etc.

Are the Finest and Best Inks and Adhesives. Emancipate yourself from the use of corrosive and ill-smelling inks and adhesives and adopt the *Higgins' Inks and Adhesives.* They will be a revelation to you, they are so sweet, clean, well put up, and withal so efficient.

AT DEALERS GENERALLY
CHAS. M. HIGGINS & CO., MFRS.
271 NINTH ST., BROOKLYN, N. Y.
BRANCHES: CHICAGO, LONDON

WORM DRIVES OPERATE BETTER WITH AUBURN THRUSTS

Worm Drives when equipped with AUBURN BALL BEARINGS are free from overheated bearings, lost motion, and consume less oil, besides lasting longer, due to maintained alignment.

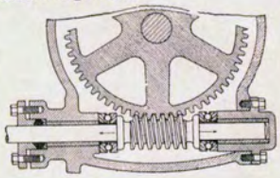


Fig. 1.

STEEL, BRASS AND BRONZE BALLS.

Send for data sheets showing how several worm gear problems were answered with Auburn Thrusts.

AUBURN BALL BEARING CO.
37 Elizabeth St. ROCHESTER, N. Y.

Samson Spot Sash Cord

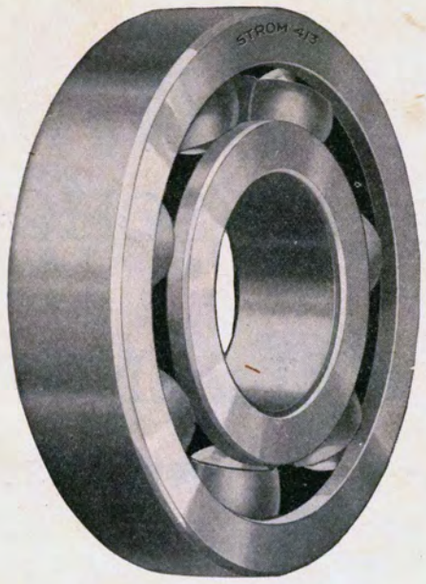
Trade Mark Reg. U. S. Pat. Off.

Made of extra quality cotton yarn, carefully inspected and guaranteed free from all imperfections of braid or finish. The colored spots are our trade-mark, used only with this quality.

We make braided cord of all sizes, kinds and colors, for all purposes, including sash cord, clothes lines, trolley cord, signal cord, arc lamp cord, and many special cords for special purposes.

CATALOGUE AND SAMPLES GLADLY SENT ON REQUEST

SAMSON CORDAGE WORKS **88 Broad Street, Boston 9, Mass.**



SELECTING THE PROPER RADIAL BEARING

In determining what sized bearing should be used for a particular installation the rule to "let the shaft size determine the bearing" can be used as a guide. It is necessary, however, to calculate the magnitude of the load and speed correctly.

Radial bearings are primarily for radial loads but may carry a slight thrust load.

For example, if a bearing with a rated radial capacity of 1000 pounds has a radial load of 700 pounds, it leaves a margin of 300 pounds. But the thrust capacity of a radial bearing is only 25% of the radial capacity so that only 75 pounds of thrust load may be supported simultaneously.

If the loads are intermittent or if the bearings are subject to shocks a larger margin of safety should be allowed.

Write for our pamphlets on: Lubrication of Ball Bearings; Limits and Allowances on Shafts and Housings; Calculating Bearing Loads; Interchangeable Sizes of Strom Bearings.

They will help you solve your bearing problem.

THE U. S. BALL BEARING MFG. CO.

(Conrad Patent Licensee)

4558 Palmer Street, Chicago, Ill.

Strom BEARINGS

LABORATORIES

OF THE

SIBLEY SCHOOL

OF

MECHANICAL ENGINEERING

CORNELL UNIVERSITY

In connection with the work in Courses of Instruction in

MECHANICAL ENGINEERING

INCLUDING

Electrical, Steam and Gas Power

Limited amount of commercial work in tests
of Materials of Engineering and the trials of

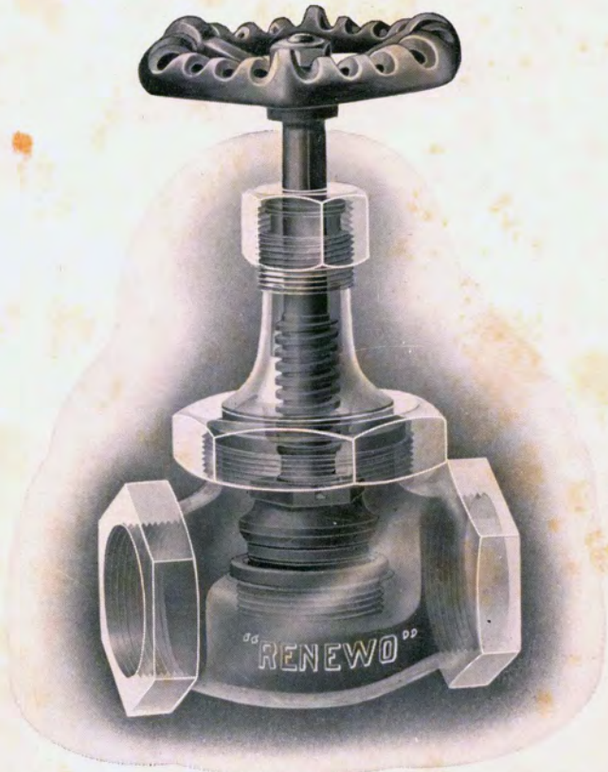
ENGINES, BOILERS, DYNAMOS, ETC.
LOCOMOTIVES AND RAILWAY APPLIANCES

CAN BE DONE AT FIXED CHARGES

FOR STATEMENT OF FACILITIES, PARTICULARS
AND PRICES, ADDRESS

Dean of the College of Engineering, Ithaca, N. Y.

LUNKENHEIMER
"Renewo" Valves



The service "Renewo" Valves give; their resistance to wear; their permanence and low upkeep cost recommend them particularly for high pressure steam lines.

The seatring and disc,—the parts subjected to the greatest wear are made of LUNKENHEIMER "valve-nickel"; the seating surfaces are regrindable, and the seatring and disc, together with all other parts are renewable.

With the materials alloyed especially for the duty each part performs; the parts generously proportioned and manufactured under the rigid LUNKENHEIMER method, "RENEWO" Valves represent the acme of perfection in valve construction.

Globe, Angle and Cross Valves with Inside Screw, and with Outside Screw Flanged Yoke Bonnet, and Horizontal and Angle Check Valves for pressures up to 200 and 300 pounds.

The LUNKENHEIMER Distributor in your locality can furnish them. Specify "RENEWO" Valves and insist on having the genuine.

THE LUNKENHEIMER CO.
"QUALITY"
LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
IN THE WORLD
NEW YORK CHICAGO CINCINNATI BOSTON LONDON
EXPORT DEPT. 129-135 LAFAYETTE ST., NEW YORK

1—21—15

CURRENT EDITION
OF CATALOG BEARS
№ 58
COPIES PROCURABLE FROM
LUNKENHEIMER
DISTRIBUTORS

1888

1921

Nikola Tesla

THE NAME of Nikola Tesla will always be associated with the invention and earlier developments of the induction motor. In fact, at one time this type of apparatus was known almost exclusively as the "Tesla" motor.

Tesla devised this motor back near the beginnings of the electrical business, when practically everything was built by "cut and try" methods, and none of the accurate analytical processes of later days had been developed. It may be said broadly that Tesla knew two fundamental facts—first, that if a magnet were moved across a sheet of conducting metal, it would tend to drag this metal along; and,—second, that the *effects* of such a moving magnet could be produced by suitably disposed polyphase currents acting on a *stationary* magnetic structure.

Perhaps others, at that time, also knew these two facts, but if so, apparently they knew them only as two isolated facts. Tesla considered them *in combination* and the result was the Tesla motor, or what is now known broadly as the "induction motor." These two facts, in combination, represent a fundamental conception, and all of the many millions of horsepower of induction motors in use today throughout the world, are based upon these two fundamentals.

Naturally, Westinghouse, having fought single handed to advance the alternating current system, was supremely interested in the new type of motor. What if the new motor did require polyphase circuits, while all existing circuits were single phase? What if it did require lower frequency than any existing commercial circuits? These were merely details of the future universal alternating system. The important thing was to obtain an ideally simple type of alternating current motor, which Tesla's invention offered. Tesla furnished the fundamental idea.

He and his associates, working for Mr. Westinghouse, proved that thoroughly operative induction motors could be built, provided suitable frequencies and phases were available. What matter if they did not produce an operative commercial system at the time? What matter if it needed the powerful analytical engineers of later date to bring the system to a truly practicable stage—men with intimate constructive knowledge of magnetic circuits—men on intimate terms with reactive coefficients and other magnetic attributes totally unknown to Tesla and his coworkers? In time the motor was made commercial, and it has been a tremendous factor in revolutionizing the electrical industry.

Probably no one electrical device has had more high-power analytical and mathematical ability expended upon it than the induction motor. The practical result has been one of the simplest and most effective types of power machinery in use today. Thus Tesla's fundamental ideas and Westinghouse's foresight have led to an enormous advance in the world's development.

Westinghouse

W
WESTINGHOUSE ELECTRIC